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Virtual Air Guitar: From Research to Business

Master's Thesis

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Instructor: Juha Laitinen, M.Sc.

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Virtual Air Guitar, a science museum installation that allowed air guitar gestures to produce music, started out as a university research project that received global media attention. Its research team founded *Virtual Air Guitar Company Oy*, a technology company and game development studio. This Thesis studies the path of research to business from multiple perspectives. The success of the original research project is analysed by assessing the involvement of a science museum and through informal user tests. The spreading of news and stories regarding the installation in both traditional media and the Internet is analysed as a media phenomenon, set against the background of air guitar as a physical dance and as part of the postmodern culture of irony, and finally compared to other media phenomena, finding that it was notable but clearly an order of magnitude smaller than the largest ones.

The Thesis also presents the elements that made it possible for the Virtual Air Guitar Company to be founded, ranging from an emerging market to new types of social games as well as recent technology advances. Against this background, the journey of a research team into founding a game development company is presented as a case study, as a series of challenges and solutions to them. These challenges include financing, finding employees and creating a team, negotiating a publishing deal for the game, managing a company, managing agile development, and patenting technology. In conclusion, guidelines are presented for what ingredients can create a successful media phenomenon and how to present research projects in the media. Some business development guidelines are also laid out for researchers starting a business.

Keywords: case study, gestural control, media, media phenomenon, Internet phenomenon, word of mouth, business development, video games, video game development, social games, music games, physically interactive games, exergaming, air guitar

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Virtual Air Guitar (Virtuaalinen ilmakitara) oli tutkimusprojektina tehty tiedemuseon näyttelykohde, joka mahdollisti musiikin tuottamisen ilmakitaraeleillä. Se keräsi merkittävää kansainvälistä mediahuomiota, ja sen tekijät perustivat *Virtual Air Guitar Company Oy* -yrityksen, joka kehittää teknologiaa ja tuottaa videopelejä. Tämä diplomityö tutkii polkua tutkimuksesta liiketoimintaan useista näkökulmista. Alkuperäisen tutkimusprojektin menestystä analysoidaan arvioimalla tiedemuseon osallistumisen tärkeyttä sekä installation toimintaa epämuodollisten käyttäjätestien kautta. Uutisten ja juttujen leviämistä perinteisessä mediassa ja internetissä arvioidaan mediailmiönä, jonka taustalla on ilmakitaroinnin ilmiö fyysisenä tanssina sekä postmodernin ironian kulttuurin edustajana. Mediailmiötä verrataan muihin, minkä tuloksena sen todetaan olevan merkittävä mutta kertaluokkaa pienempi kuin suurimmat internet-ilmiöt.

Työssä esitellään lisäksi Virtual Air Guitar Company Oy:n perustamisen mahdollistaneet tekijät vastasyntyneestä markkina-alueesta uusiin sosiaalisiin peleihin sekä teknologian kehitykseen. Tätä taustaa vasten esitellään case study yrityksen perustamisesta sarjana haasteita ja niiden ratkaisuja. Haasteisiin kuuluvat mm. rahoitus, rekrytointi ja tiiminrakennus, julkaisusopimuksen neuvottelu, yrityksen johtaminen, ketterän ohjelmistokehityksen johtaminen ja teknologian patentointi. Lopuksi esitellään suosituksia siitä, minkälaisista elementeistä voi syntyä mediailmiö ja kuinka tutkimusprojekteja kannattaa esitellä mediassa. Työ myös tarjoaa suosituksia liiketoiminnan kehitykseen tutkijoille, jotka ovat perustamassa uutta yritystä.

Avainsanat: case study, eleohjaus, media, mediailmiö, internet-ilmiö, word of mouth, liiketoiminnan kehitys, videopelit, videopelien kehitys, sosiaaliset pelit, musiikkipelit, liikunnalliset pelit, exergaming, ilmakitara

Acknowledgements

This Thesis was written for researchers thinking about founding a business. It was written as something that I myself would have wanted to read when I found myself in the same situation.

The Thesis would not exist – and indeed, I would not have this job at the best darn game company around – without the Virtual Air Guitar Company and its people. Therefore, I offer my sincere thanks to Teemu Mäki-Patola and Juha Laitinen, the other two original developers of the Invisible Guitar science museum installation and the other two co-founders of the company, Pirjo Kekäläinen-Torvinen for pushing me to finish this Thesis, and Markus Eräpolku, Tommi Tykkälä and Oskari Martimo for their work in the self-same company – and for letting me focus on actually getting this Thesis done.

I also give thanks to Juha Laitinen a second time, for being my instructor on this Thesis and providing invaluable feedback.

Finally, my thanks go to prof. Tapio Takala, the supervisor of this Thesis, not only for his supervision, but also for hiring me into the ALMA project to begin with. The international ALMA project, without which there may never have been an invisible guitar, is to be commended for connecting like-minded researchers.

Contents

Chapter 1

Introduction

What made the research project such a success, and how could a similar media boom be replicated? What were the challenges faced by a team of researchers founding a game development company, and how were they solved? This Thesis was written to be that one concise look into going from research to business that I would have wanted to read when our team started thinking about founding a company.

The Thesis is divided into three main parts. Chapter 2: *Invisible Guitar* describes the Invisible Guitar, the initial technological experiment that was on display as an exhibit at Heureka – The Finnish Science Centre. The project is evaluated in the same chapter to provide the setting for further analysing its success in the subsequent chapters.

The idea of playable air guitar gained considerable publicity, both in traditional media and the Internet. Chapter 3: *Media Phenomena* attempts to answer the question of why the idea was easy to understand and spread so widely by analysing the cultural backdrop of rock music, air guitar and Internet culture. The chapter also presents a study of the Internet phenomenon through comparison.

Chapter 4 *Starting Up a Business* goes on to analyse the market and business atmosphere that led to the possibility of founding the company. It discusses the challenges we faced in starting up a business and presents a collection of guidelines for researchers wanting to commercialise their work. While these guidelines and what we learnt are summarised in chapter 5: *Conclusions*, I have kept most of the analysis in chapter 4. My reasoning for this is that I hope that the description of the actual work we did is of value to the reader, not only the end result of the process.

Both the original research project and the subsequent business start-up were very much team efforts. This Thesis will describe the projects that I took part in, and I will note my responsibilities where applicable. My other main contribution in the Thesis is the analysis of the process that resulted in a company being founded.

1.1 What is Air Guitar?

> "Air guitar is a form of dance in which the performer pretends to play guitar. Playing an air guitar consists of an exaggerated strumming motion and is often coupled with loud singing or lip-syncing. Air guitar is generally used in the imaginary simulation of loud electric guitar music, especially rock, heavy metal, and so on." [22]

Though many people seem to know what playing air guitar is, it is difficult to define precisely. The quote above summarises how it appears to onlookers, but not its meaning or the reasons behind it. I have collected my personal thoughts on air guitar here, dividing it into three aspects.

At the core of air guitaring is the imitation of rock stars, the wish to be a star oneself. It is not so much a simulation of guitar playing, but rather of a famous rock guitarist performing on stage to an audience of fans. Air guitarists imitate the trademark gestures and poses of these rock stars, which may or may not have much to do with actual guitar playing. Some rock guitarists have made their stage performances more visual than is necessary to actually produce sound from the instrument, ranging from walks, jumps, poses and flashy gestures all the way to physically breaking the guitar or setting it on fire. All of these are elements of showmanship, ways of impressing the audience with more than just the music. And rock in its various sub-cultural movements has always been about more than just the music.

An early exhibit of the above can be found on the 2004 DVD documentary of the history of Iron Maiden [5], a famous rock band. In one scene of the documentary, band members reminisce how fans in the 1970's would come to the band's concerts with wooden and cardboard guitars and emulate what was played on stage. This example demonstrates one of the core ideas behind air guitar: fans' attempt to emulate their hero, a rock star. My opinion is that rock stars are often seen as larger-than-life figures, and people want to grasp that stardom for a moment and imagine being adored by countless fans and living a dream life. Thus, air guitar has primarily been something performed by fans of rock music.

The second aspect of air guitar is light-hearted fun at the expense of the icons of popular culture. According to Magnus Langli, organiser of the Norwegian air guitar championships, "everyone can play air guitar, and therefore it is very including. The more people do not expect you to play, the funnier it is. For example if an old lady should play, that would be really hilarious" Likewise, Marie-Pierre Bonniol of the French air guitar championships says that they are most interested in "the b-sides of music because they are what keeps it fresh and fun", referring to the quirky and entertaining aspects of popular music culture.

This combination of imitation and hilarity marks air guitar as a prime example of postmodern irony. Steve Bailey analysed the ironic cover albums of Bryan Ferry and Todd Rundgren in [2], and mentioned that cover albums, even ironic cover bands, have surfaced in more recent years, just like in other forms of popular entertainment. These acts ridicule the original music and artists for comic effect, but at the same time there is a reverence in them. Air guitarists do the very same, the only exception being that they are not musicians.

The third aspect of air guitar is a physical one. To play air guitar is to move

in time to and in interpretation of music – in essence, a dance whose aesthetics are derived from rock guitarist performances. A good air guitar performance flows with the music and attempts to capture both the playing and the attitude of the original player – or replace the latter with the air guitarist's own show. Rhythmic movements are important, because they tie the performance in with the music. As with dancing of any kind, skillful execution of rhythmic manoeuvres is impressive to watch, and feels good to perform.

The visual aesthetics of this dance seem to come from what fans see at rock concerts rather than the attempt to accurately replicate the gestures that produce sound on a guitar. Some rock guitarists emphasise a visual performance as part of their concert. Pete Townshend, guitarist of The Who, is a good example. He is famous for his trademark guitar moves such as the windmill (flailing the right hand fully extended in a circle after playing a chord) and breaking a guitar at the end of the show. In an interview with the Rolling Stone magazine in 1968 [19], Townshend says that he is frustrated at not being a great musician. "I used to try and make up visually for what I couldn't play as a musician. I used to get into very incredible visual things where in order just to make one chord more lethal, I'd make it a really lethal-looking thing, whereas really, it's just going to be picked normally. I'd hold my arm up in the air and bring it down so it really looked lethal, even if it didn't sound too lethal."

Air guitar has also given birth to entertainment events. Since 1996, official Air Guitar World Championships have been held in Oulu, Finland, in conjunction with the Oulu Music Video Festival [23]. Every year, competitors from all around the world take part in the championships by playing air guitar to two songs: one compulsory song that is the same for all competitors, and one song of their own choosing of exactly 60 seconds in length. Performances are evaluated by a jury on a scale of 4.0 to 6.0 based on originality, the ability to be taken over by the music, stage charisma, technique, artistic impression and "airness". National competitions are held in many countries to determine who gets sent to Finland for the finals. In 2007, there were 17 countries with national competitions.

Olli Rantala, organiser of the Air Guitar World Championships, likens air guitar to karaoke. According to him, people have sung along with their favourite songs for a long time, but karaoke allowed them to have the courage to step on the "stage" and perform themselves. Likewise, the world championships have allowed air guitarists to get up on the stage and perform for an audience. Still, the Air Guitar World Championships are to air guitaring what major karaoke competitions are to singing at home with friends. Air guitar is played at concerts, at home, alone or with other people, and for many different reasons.

1.2 Background

The very first prototype for the user interface of a playable air guitar was developed as part of the ALMA project. ALMA (ALgorithms for the Modelling of Acoustic Interactions, [24]) was an EU-funded research project, whose participants included the Telecommunications Software and Multimedia laboratory (TKK/TML) and Acoustics laboratory of TKK, as well as the Erlangen-Nürnberg University in Germany, Milano Polytechnic University in Italy, and

the Italian synthesiser manufacturer Generalmusic S.p.A.

ALMA began in 2001 with the purpose of advancing sound synthesis to match the leaps taken in the visualisation of virtual reality. Every year had brought advances in 3D graphics to make even more realistic visuals, but research in the modelling of sound and acoustics had not been nearly as fast. In particular, the project concentrated on modelling musical instruments in a physical, block-wise manner. This meant that instead of trying to reproduce the final sound of a specific instrument, virtual instruments could be built from "blocks" with real, physical characteristics, such as pieces of wood and strings. The acoustic interactions between these components would then produce the final sound, and it could be tweaked by altering the physical properties of each component, just as it would happen in the real world.

In essence, these virtual instruments would be mathematical simulations of complex physical systems. Where the other participant laboratories created both the simulations themselves and the block compiler environment for them, TML focused on building the user interfaces for musicians to be able to use the models. The sound models, software running on a computer, were controlled by a large list of parameters related to the simulations. Musicians are rarely experts on algorithms, so the user interface for a virtual instrument would have to hide the parameters and give the user a more natural, hands-on feel for the instrument.

These interfaces were largely inspired by the work of Marcelo M. Wanderley et al. on gestural control of musical instruments ([15, 17, 16, 18]). In his Ph.D. Thesis, Wanderley presents the challenge of researching meaningful mappings between user input and sound model parameters: "– I would claim that mapping is still an unexplored area in digital musical instrument design, and that a shift of researcher's attention is needed from ubiquitous trend to constantly design new controllers and map their output variables using one-to-one mappings to the available synthesis input parameters." [15, pp. 73-74]. This, in fact, was the basis for all the work of TKK/TML in ALMA – not developing new sound models with parameters, but trying to find meaningful control methods for existing ones.

TKK/TML was also researching virtual reality graphics and interfaces at the time, and had a CAVE-like VR room for this, called EVE (Experimental Virtual Environment, [26]). In the EVE, the user was surrounded by three 3-by-3 metre walls, from behind which an image was projected onto each wall, and additionally on the floor. The user viewed these stereoscopic images through stereo shutter glasses, providing a slightly different image for each eye for a 3D illusion. The room also contained a Flock of Birds magnetic tracking system by Ascension Technology Corporation, consisting of a magnetic field generator and magnetic sensors. The sensors were connected with wires to a computer, and reported their location and orientation in the magnetic field at a rate of 100 times per second. By attaching one sensor to the stereo shutter glasses, the user's head could be tracked and the camera in the virtual scene matched to the user's viewpoint. Other sensors could be attached to the user's hands, so she could move objects around in the virtual scene. Data gloves that measured the bend angle of fingers could be used for detecting grabbing. Finally, the room had a 16-speaker surround sound system and surround panning software.

So, a technological environment for creating virtual reality interfaces was in place, and it was decided to develop virtual instruments there. In the spring

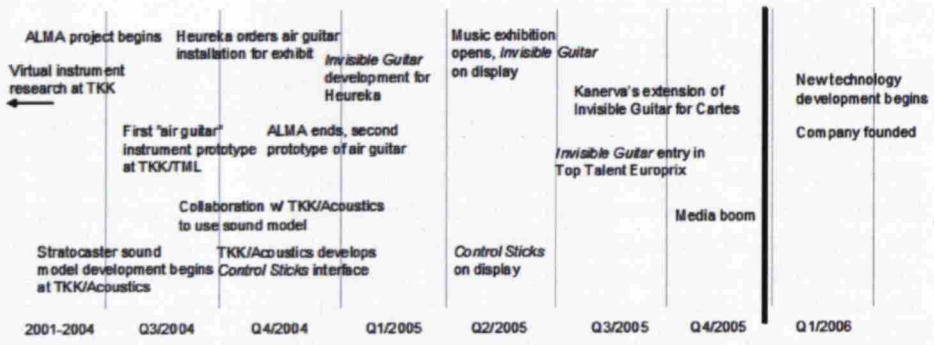


Figure 1.1: Timeline of research and projects leading up to the Invisible Guitar and the founding of the Virtual Air Guitar Company.

of 2004, a generic software platform for developing these virtual instruments was in place. The first instrument used to test the platform was a simple air guitar. The sound model (a basic Karplus-Strong model [8]) used vaguely sounded like an acoustic guitar, and only had a single string. It was controlled with two parameters: bending the fingers of the right hand plucked the string, and the distance between the left and right hands controlled the pitch. The pitch control was completely continuous, there was no quantisation to a musical scale. Effectively, the player could make a wailing sound that smoothly changed in pitch, reminiscent of the Theremin or an early synthesiser.

It wasn't so much the sound, but the attitude of the player that made it fun. I joined the ALMA project in the summer of 2004, and tried out the air guitar myself. While there was nothing that forced me to use air guitar gestures, it was a great deal more fun to play when I imagined a guitar between my hands, and took poses reminiscent of rock stars on stage.

Juha Laitinen joined the project at the same time, and the three of us developed more virtual instrument interface prototypes under professor Tapio Takala. One instrument was a virtual drum plate, whose physical properties (size, hardness, material, etc.) could be controlled with virtual sliders, and gesture detection was used to hit the plate with a virtual mallet by swinging the hand. There were two variants of an advanced Theremin, made more easy to play by quantising the sound so that hitting musical notes was easier, implementing a visual keyboard to help with determining where notes were, and making the scale linear rather than logarithmic. A virtual xylophone was also developed, where the player could grab and move plates around in 3D space all around them.

The *Virtual Air Guitar* itself was not just a single project, but rather a name that was applied first to prototypes developed within ALMA, and later on in further iterations developed for Heureka and Cartes. Figure 1.1 shows a timeline of the various projects and research that preceded the founding of the Virtual Air Guitar Company. This timeline continues at the beginning of chapter 4, focusing on the first year and a half of the company.

Chapter 2

Invisible Guitar: Science Centre Exhibit

The Invisible Guitar refers to an exhibit at Heureka – The Finnish Science Centre. It was developed in 2004-2005, and displayed at the science centre from March 2005. The development team were three students, including myself, from TKK Helsinki University of Technology, Telecommunications Software and Multimedia Laboratory, and was built on previous research on virtual instruments as well as concurrent research in sound modelling at the Acoustics Laboratory of TKK. The exhibit did not have an English name at that time – Heureka called it either "soiva ilmakitara" or "ilmakitara – hanskat" ("sounding air guitar" and "air guitar – gloves" respectively). Earlier on in the ALMA project, we called the air guitar prototype *Virtual Air Guitar* in line with the other prototypes (*Virtual Xylophone, Virtual Theremin, etc.*). Once the Heureka project was finished, the science centre settled on the name "Invisible Guitar".

This chapter describes the research and events that led up to the Invisible Guitar, discusses its special requirements and implementation, and analyses its success.

2.1 Background: The Involvement of Heureka

Near the end of the ALMA project in the summer of 2004, Heureka – The Finnish Science Centre became interested in obtaining something to use as exhibits in its upcoming Music exhibition. The research for the air guitar began in ALMA, but after it ended, the Heureka version was developed outside the context of a larger research project. The Invisible Guitar can be seen as the tail end of a project that started during ALMA, but also as a separate finalization project of the prototype developed in ALMA. As a separate, small-scale student project of three months, it is uncommon that it had a commercial customer – but on the other hand, the finalization project was based extensively on existing work and collaboration.

The first contact to Heureka came through Jukka Tiilikainen, the coordinator of the Music exhibition and a music researcher at the Helsinki University. He had only joined Heureka to organise the one exhibition. We met through the meetings of the Cost287-ConGAS (Gesture CONtrolled Audio Systems) group,

part of the COST initiative whose purpose is to connect scientists around Europe. At the time, the ALMA research was being displayed for other researchers and performers interested in gestural music control. Through the same group, we also discovered that TKK's Acoustics Laboratory was developing a physical sound model of an electric guitar, which would later be joined in with our user interface.

Heureka was particularly interested in the air guitar prototype, as well as a drum simulator which allowed the user to change the physical properties of a drum plate while she was playing. In their view, the air guitar not only showcased the science of physical sound modelling, but also explored aspects of music psychology relating to the act of playing an instrument and what it means to learn how to play.

The project to create the Invisible Guitar was taken up to continue the ALMA research – initial work on the webcam interface and the first prototype were done within the scope of ALMA, but the implementation continued after ALMA had ended. It would not be financed other than Heureka providing the hardware to run the installations. Our research project was called Virtual Air Guitar at the time, but the science centre exhibit was later named the Invisible Guitar. My contribution to the project was the musical logic module, described in detail in Chapter 2.4.

To our knowledge, the other results of the ALMA project were not commercialised in any way, except for the Acoustics Laboratory's own air guitar exhibit for Heureka that used a different, tangible interface and no logic component (see section 2.6.2). For us, it was important to have a real customer who provided requirements and deadlines that were more related to commercial work than research, even if no money was involved. Without Heureka's requirements, the Invisible Guitar might not have turned out as well as it did – if the project had even been started at all.

2.2 Requirements

Creating a science centre exhibit imposed certain requirements on the design of the installation. The exhibit would be in an unmonitored area, available for children and adults to use at will. It would be one among several exhibits.

Visitors should be able to learn how to play the Invisible Guitar in a matter of seconds – if it's too difficult to play, they would quickly lose interest and move on to the next exhibit. Even so, being able to discover something new after a few attempts would make the visitors come back to it again and again. Conversely, playing should be fun for about a minute, because there are plenty of other exhibits to see, and long queues are undesirable.

In terms of construction, the exhibit should be durable and able to withstand anything that children can come up with. Additionally, it should be able to run on its own, require little maintenance, and recover automatically from errors. It was apparent that setting up an entire virtual reality room at Heureka would not be practical, and so it was decided to use computer vision for the interface instead. In addition to webcams being cheap, the system could not be broken through misuse because it had no moving parts or tangible objects (other than gloves).

Figure 2.1: Photograph of team member Teemu Mäki-Patola rocking out with the Invisible Guitar. The TV screen is shown in the top left corner, and the rest of the hardware is hidden in a rack behind the mesh doors.

2.3 Description

To play the Invisible Guitar, the player puts on a pair of orange gloves and steps in front of a display. She sees herself on the screen, thanks to a camera placed on top of the display. The camera feeds its image to a computer, which recognises the player's gestures and controls a physical sound model according to them. The result is the sound of a distorted rock guitar coming through a pair of speakers, reacting to the player's movements. A photograph of a player wearing the orange gloves is shown in Figure 2.1, and the display is shown in Figure 2.2.

There are two playing modes, the first of which is called "chords". The player places the right hand near the waist, and the left hand is extended as if holding an imaginary guitar's neck. Moving the right hand in a top-down down motion as if strumming the strings of a guitar results in a chord being played on the bottom three strings of the virtual guitar. This chord consists of the base tone, fifth interval and octave interval, commonly known as a *power chord* among guitarists.

The distance between the left and right hands controls the pitch of the sound. Moving the left hand further away from the right hand (down the guitar's neck) and then strumming results in a power chord played from a lower position, and moving the left hand closer gets you a higher-pitched chord. There are four transpositions of the power chord available that correspond to four hand distances. If played in a certain order with a certain rhythm, it is possible to play the main riff of the Deep Purple song *Smoke on the Water*, but the player is in no way restricted to playing the song if she doesn't want to.

Pressing a foot pedal switches between the two modes. The other mode is called "solo", and allows the player to play on a minor pentatonic scale, which is commonly used in many rock and blues guitar solos. The controls of strumming

Figure 2.2: A photograph of the Invisible Guitar's display. The player sees himself on screen, with the orange gloves highlighted. The bottom left corner shows an icon of the currently selected play mode, and the bottom right corner shows time remaining.

and hand distance remain the same, but instead of chords, each strum generates an individual, higher-pitched note played on one of the three top strings. Additionally, even a bottom-up strumming motion triggers a note, allowing the player to play twice as fast.

In addition to triggering notes, the player may also add vibrato to the sound by rapidly shaking the left hand, and perform slides by moving the left hand without strumming. The sound can be muted by hiding the gloves, e.g. behind the player's back. Finally, really intense playing adds extra crunch and distortion to the sound that changes it quite dramatically, allowing the player to get some truly unique sounds.

2.4 Technology

The Invisible Guitar consists of three main components: camera input and gesture recognition, musical logic, and sound model. The user's movements are picked up by the camera and interpreted by the gesture recognition module. The musical logic module converts the input data into meaningful control data for the sound model, which outputs rock guitar music. Figure 2.3 shows a simplification of how the system works.

At the end of the chain is the sound model, an Extended Karplus-Strong algorithm [6] that calculates the sound of a guitar in real time. The algorithm itself was first implemented in 1983, but the version used in the Invisible Guitar was calibrated to sound like a hand-made copy of a Fender Stratocaster guitar by Matti Karjalainen and the Acoustics laboratory of TKK [7]. The sound is then patched through DSP effects that simulate a vacuum tube guitar amplifier to give it characteristic overdrive, as well as digital chorus, delay and reverb.

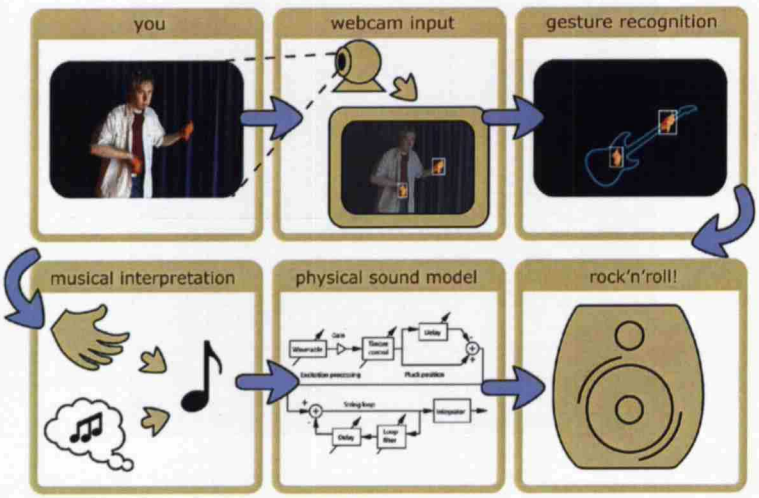


Figure 2.3: A visual representation of the Invisible Guitar's technology modules.

However, the Extended Karplus-Strong model is an algorithm rather than an instrument, and as such is controlled by four parameters: delay line length, pluck position, and two dampening factors. To make it easy to instruct the algorithm to play certain musical notes and guitar techniques, a guitar meta language was developed. The meta language is an event-based control language somewhat like the one used in the MIDI protocol, but for guitar events instead of standard, keyboard-based General MIDI synthesisers. So, instead of *note on* and *note off* events, the guitar meta language had events such as *pluck, mute, palm mute, vibrato,* and so on. With this meta language, it was easy to define the chords of *Smoke on the Water* and the minor pentatonic scale used in the solo mode. The guitar meta language was an implementation of the ALMA control language developed within the ALMA project.

The input that is used to generate meta language events comes from the input module. The web camera captures the player on video at 30 frames per second. The gloves are recognised by their colour – the gloves themselves are plain fabric. A line is drawn through both hands, which represents the imaginary guitar's centre line. Moving the right hand over the centre line is considered a *pluck*. The centre line follows the hands with a delay (a low-pass filter), so that small, rapid movements of the right hand do not change its position, but if the player moves left or right or raises the guitar, the centre line follows. The input system was developed by Juha Laitinen, who improved on it for more virtual instrument experiments in his Master's Thesis [10, see particularly pp. 13-18].

Plucks and hand distance are sent to the musical logic module, which interprets the data as a musical performance. For example, in the solo mode, when a pluck is triggered and the hand distance is at 20% of the neck's length, a meta language event for plucking the high E string at the 5th fret is generated. The musical logic module works as a *complex mapping* between the player and the sound model. Each module is described in more detail in [7].

The system ran on a Linux platform. There were a few components that we did not develop, which were all open source software. These were the IEEE-1394 FireWire camera interface for reading video from the camera, the Mustajuuri

digital signal processing engine [36] in which the sound model ran, and the DSP guitar effects which were parts of the CAPS Audio Plugin Suite [29].

2.5 Rationale for Choices Made

2.5.1 Musical Logic

Right from the start, the goal of the Invisible Guitar was to strike a balance between entertainment and expressivity. Easy learning usually means that expressivity has to be limited somehow by preventing the user from making mistakes. It takes years to learn how to play guitar, but we wanted every player to sound like a rock guitarist – for the short time of playing the Invisible Guitar.

The solution was to build a musical logic that simply does not allow the player to hit any wrong notes, and choose the ones that can be played from a palette that sounds typical to the genre. However, that did not mean that expressivity could not be added on top of that. By giving the player the secondary controls of vibrato, muting, slides and the two play modes in general, each player could customise the playing to sound different from anyone else.

Additionally, it simplifies the interface of a real guitar while still maintaining the core idea of air guitar – giving a visual performance. We designed the interface based on a non-guitarist's perception of how a guitar is played. On a real guitar, the same notes can be played at different locations of the fretboard, and guitarists use all six strings when they play. A scale of 12 notes can be played on one string from fret 1 to 12, or it can be played on three strings, each using frets 9-12. In fact, in a technique called *position playing*, the guitarist prefers to keep her left hand in the same position this way.

We assumed that many non-guitarists would not know this, however, which turned out to be a good assumption in informal user interviews both during development and afterwards. The larger movements of the left hand are more likely to be seen by the audience. So, we simplified pitch control into the single variable of hand distance. This also conformed with the limitations of the technology – individual fingers could not have been detected with a single basic web camera anyway due to low resolution and occlusion problems.

In the solo mode, the musical logic module maps the hand distance into six notes, but played around the 5th fret on the three top strings. Figure 2.4 illustrates this. The scale used is the fifth inversion of E minor pentatonic. Since each string sounds slightly different, this made the sound a little bit more varied than it would have been if only a single string was used.

The distortion boost that is triggered by intense playing was originally an error in the system. When the left and right hands were so close to each other that they momentarily became one orange blob, sometimes two or three strings would sound at the same time. Driving this sound through the amplifier module would greatly increase the effect of distortion because of the interference of harmonic resonances. The effect sounded so great that the "bug" was developed further into a feature, which ended up as one of the most fun aspects of the Invisible Guitar. The important thing was that the effect was not random, but could be achieved at will by playing very intensively with the hands close together, mimicking intense solos of real guitarists. Thus, the intensity of performance could affect the sound dramatically, something which could not have

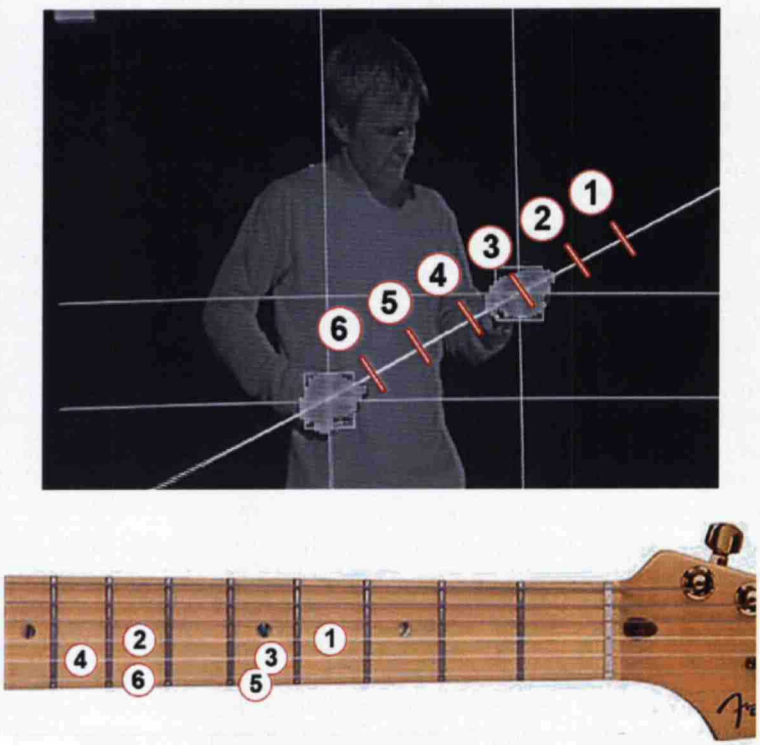


Figure 2.4: Visual representation of mapping hand distance to notes on guitar fretboard. The distance parameter has six values (1-6, top picture) that are mapped to the fretboard in the bottom picture. The same notes (B, D, E, G, A, B) could have been played on just a single string.

been achieved just by increasing the number of notes one could play.

2.5.2 Visualisation

Originally, the visualisation was different, too. The gloves had horizontal and vertical target lines running through them, the guitar centre line was drawn on screen, and each pluck was visualised momentarily as a square in the location where the hand had passed over the centre line. However, these visualisations were dropped from the final version as a result of user tests. During informal testing sessions at Heureka, we noticed that users tended to focus on the visualisations so much that they couldn't concentrate on playing. Removing the visualisations made the playing more focused on the player and less like trying to control the computer.

Following this discovery, we also tested playing completely without a display. However, this proved unsuccessful, and users seemed to have more fun with a display than without one. The display provides feedback on how the system works – simply seeing that your gloves are being recognised tells you how the system works on a general enough level, and you can also spot if the system isn't recognising you properly or if you're not inside the camera's field of view. The display also added the extra fun element of seeing yourself on TV, which, especially among children, was sometimes just as fun as the actual playing.

Finally, it can be speculated that the display provides a point of focus that the user can concentrate on. If there is no display, the user is too aware of her surroundings and that other people are watching her. With the display, the user can focus her attention on the screen and herself.

2.5.3 Hardware and Software Platform

The biggest of the exhibit's requirements was durability, so much so that it dictated our choice for input system. By using a camera to track the user, we were able to hide all of the fragile technology behind safe doors. The only thing that the user would touch were the gloves, which were cheap enough that the science centre had literally thousands of pairs in storage. The foot pedals came from the science centre, and were sturdy enough to withstand quite a lot of punishment.

The camera input component was very simple, and could not adapt to changes in lighting. It simply detected a predefined colour from the image. So, we had to make sure that the gloves were evenly lit from the camera's direction, which resulted in the three fluorescent tube lamps as seen in Figure 2.1. The installation was surrounded by walls three metres tall to prevent light leakage from outside and the crowd from entering the picture. Additionally, a light-blocking cloth partially covered the otherwise open ceiling of the exhibit.

The choice to use only free or open source software came from the fact that the project was non-commercial and the budget was small. Additionally, it meant that there were no licensing problems that would have been present with commercial software. Finally, a Linux system was more stable than Windows, and could easily be prevented from using unnecessary background processes.

We ended up using an Apple iSight camera for the installation, as it was one of the few cameras with a FireWire connection. This requirement had come from the lack of generic USB camera support for Linux – they relied

on closed-source drivers from each manufacturer separately. The iSight had a better image quality than other FireWire cameras we tested, and the 54.3 degree viewing angle was just large enough to allow the player to stand no further than 3 metres away from the screen.

2.6 Evaluation

As a science centre exhibit, the Invisible Guitar was very successful. According to Heureka, it was the most popular attraction in the year that the Music exhibition was running. The second most popular one was the Invisible Drum developed by the same team, another continuation of an instrument from the ALMA project, using the same technologies and camera interface.

The system had a play counter feature that measured the number of times it had been started. Over the course of the year, this counter reached 60 000. If we assume that most of these played until the end of the 100-second period and that the centre is open 6 days a week, this means roughly 4,5 hours of continuous playing every day. After the Music exhibition was closed in March 2006, the Invisible Guitar was made a permanent exhibit.

It was also very robust. If the software crashed, it would restart itself within 10 seconds, and if it did not, maintenance only had to restart the computer by pressing the power button to get it running again. Only on one occasion did the system require maintenance from the original development team. The camera chosen for the installation (an Apple iSight), however, was prone to overheating in prolonged use, and had to be replaced several times.

2.6.1 Playing fun

It was easy enough to learn to play the Invisible Guitar – just moving your hands produced something that didn't sound bad, and many users we observed picked up the idea in about ten to twenty seconds. The 100-second playing time proved to be a very good limit and encouraged people to let others play. If there were no queues, nothing was stopping a user from pressing start again to try and discover something she hadn't tried yet.

Despite the fact that there are only six notes available in the solo mode, it is very expressive thanks to vibrato, slides and the intensity boost. No two playing sessions are the same, and we even discovered that certain people who played a lot had their own distinct styles that sounded different from others.

Still, the musical logic was somewhat limited in the sense that the end result did not sound too much like a rock guitarist – it certainly couldn't be called an intelligent simulation, but rather a collection of simple heuristic rules. The sound model itself was flexible, and could reproduce the sound of a guitar string being plucked and let ring. However, a real guitarist is constantly producing sounds in more ways than just plucking strings, such as bending the strings, brushing, muting, letting strings clatter against the fretboard, producing secondary sounds from moving fingers around on the fretboard, and so on. Some of these could have been simulated by heuristic rules, but many were simply beyond the sound model's capabilities.

A side effect of hiding the technology inside the rack was a more "natural" feel to playing. We speculated that playing did not feel like controlling a computer

program, because all the user could see was herself on screen, and hear the sound of the guitar.

2.6.2 Comparison to "Control Sticks"

While we were developing the Invisible Guitar, the Acoustics Laboratory was also working on their own user interface for the same sound model they had given us to use. The development of this system, called "Control Sticks", was headed by prof. Matti Karjalainen, the creator of the sound model. It was a simpler interface that omitted the gesture recognition and musical logic modules, and connected the input directly to the sound model. This system is also described in [7].

The input system consisted of two control "sticks", one shaped like a large plectrum and the other like a miniature version of the very top of a guitar neck. Wires connected both pieces to a computer (but not to each other). The neck part contained a speaker that sent ultrasound signals that were received by a microphone in the plectrum, and by measuring the timing of the signals the computer was able to calculate the distance between the two pieces. This distance was mapped directly to the pitch of the sound in the sound model.

The result was a very different playing experience. The way to play was to pick a note with the plectrum to start it ringing, and then move the left hand back and forward to create a wailing sound. A foot pedal could be used to control the length of the next note to be picked (a palm mute). Chords and melodies could not be played, but it was still fun to reproduce the strange guitar effects that were reminiscent of Jimi Hendrix's experimentations.

Unfortunately, the system was not very robust, and often stopped working for long periods of time at the science centre. Additionally, the physical objects of the interface limited the player to just experimenting with the sound and not giving a visual air guitar show. The gamut of sounds produced was also rather small, and after initial experimentation there was nothing new it could give to the user.

2.6.3 Comparison to a Real Guitar

The core idea of the Invisible Guitar was to make it more of an entertainment device than an expressive instrument. We wanted to make it as easy to learn as possible, so that the player wouldn't have to spend years learning how to play as with a real guitar. Some time into the project, I bought an electric guitar, both out of personal interest and because I thought it would help understand different playing techniques to better simulate them.

After I had learnt the basics of real guitar playing, I was able to make comparisons between it and the Invisible Guitar. My feelings were that the two cannot be compared as instruments, but there are some similarities. The Invisible Guitar was indeed more about just letting go and having fun, especially among friends. The fun of playing a guitar for me at the basic level came from practising and finally experiencing the joy of playing a piece correctly.

Another aspect of the real guitar that was entertaining to me was discovering improvisations that sounded good. This is something that was also present in the Invisible Guitar. It was possible to learn certain playing techniques through

experimentation – such as the "boosting" effect – and repeat them to reproduce similar sounds.

We also observed real guitarists playing the Invisible Guitar. Most of them tried to use controlled, minimal gestures as if they were playing a real guitar efficiently, and seemed unable to just let go and ignore accuracy. This was confirmed in informal discussions afterwards, where multiple guitarists claimed they were frustrated because they could not pick out exactly the notes or chords they wanted to. It seemed to us that the less one knew about guitar playing, the easier it was to throw oneself to air guitaring.

2.7 Further Developments

After the science centre project had been completed, I began developing a new version of the system for Cartes, the Centre of Computer Arts in Espoo. There were two primary goals, one of which was to develop a Windows-based generic platform for creating gesture-controlled instruments, and the other was to implement the Invisible Guitar on this new platform with more work put into the musical logic. The original system ran well on Linux, but was difficult to install, so a Windows version might have a broader audience in desktop users.

The platform was built by porting the camera input software to Windows, and the musical logic and sound synthesis were implemented in Miller Puckette's Pure Data computer music environment [13, 38]. In particular, I attempted to create a modular environment for constructing complex mappings from premade modules, such as quantisation to musical scales and Markov chains, which could then be used to control any sound model.

However, recreating the Invisible Guitar on this platform proved to be difficult. The same modularity that allowed quick, rough prototypes made it hard to create complex, finished products like the Invisible Guitar. By the time the system consisted of dozens upon dozens of interlinked modules, it would have been both easier and more efficient to program the application without so much modularity.

Still, the musical logic was taken forward somewhat. The new version of the Invisible guitar contained small additions, such as an inverted pentatonic minor scale instead of a straight one, logic to play the guitar techniques of hammer-ons and pull-offs, and other techniques such as blues bends and finger muting to be triggered semi-randomly. These small additions made the sound more attractive, and a step closer towards sounding like a real guitarist.

The results of the project remained unused in the end, however. The only step towards a more commercially viable system was that it ran on Windows, which might have made it easier to package into downloadable software. It did not really offer much more than a basic distribution of PureData or Max/MSP. Finally, the attempt to reproduce the Invisible Guitar on the platform only showed that it would have been better to rebuild it from scratch without using a middleware platform such as the one I had developed.

Chapter 3

Media Phenomena

In November 2006, the Virtual Air Guitar gained considerable international publicity. A project web site had been created near the end of the research in early 2005. During the spring of 2005, domestic media made a few stories about Heureka's Music exhibition in general, and some about the air guitar exhibit in particular, but on the overall, media attention was scarce.

Then, in late November, the research web site was spotted by a blogger [25], who tipped off a friend who was an editor at New Scientist Online. The research team was interviewed, and following the news story on New Scientist Online [33], interview requests began to flood in from all around the world. Over the next two months, interviews were given to international TV programmes, radio stations and newspapers, ranging from Discovery Channel and National Geographic TV to the BBC News. Additionally, the Virtual Air Guitar was featured in hundreds of blogs and newsfeeds on the Internet. Interview requests continued throughout the spring of 2006 at a slower pace.

This chapter examines the magnitude of this publicity and attempts to shed light on the reasons why the idea of playable air guitar received such attention – and how it could be replicated for a different concept.

3.1 Background

3.1.1 On the Popularity of Air Guitar

Air guitar is something special. I do not believe that any other virtual instrument could have got quite the same reception as the Virtual Air Guitar did. We, the development team, did not intend it to be an expressive instrument for professional musicians, but a lightweight "entertainment instrument", a way for people to feel like a rock star for a moment – to embrace all three aspects of air guitar presented in the introduction to this Thesis.

In recent years, air guitar had been rising in popularity as a cultural phenomenon. The Air Guitar World Championships held at the Oulu Music Video Festival in Oulu, Finland annually since 1996, had been attracting more and more global audience and media attention. Air guitar's popularity had been present in the USA as well, but gained a significant boost in 2005, as presented by the 2006 documentary film *Air Guitar Nation,* directed by Alexandra Lipsitz.

Since 1996, there have been annual Air Guitar World Championships held in Oulu, Finland, in conjunction with the Oulu Music Video Festival. According to the official web site [23], the championships started out as one event among many in the art festival, and the first event only had Finnish competitors. More and more international competitors took part in later years, some accompanied by minor media, but 2001 marked the event's first international success. For the first time, the winner was not a Finn, but came from the UK instead. Major international media outlets had also taken interest in the event, and stories were featured in popular magazines such as Time and Wall Street Journal. This would indicate that air guitaring was becoming known even outside the rock music circle.

After this, official organisations for conducting national championships began forming in various European countries, to determine who would represent each country in the world championships. I interviewed Olli Rantala, organizer of the annual Air Guitar World Championships at Oulu, Finland, as well as organisers of the Austrian, British, Dutch, French and Norwegian national championships. They all replied that while air guitaring has been around for a long time, the world championships held in Finland sparked up the interest to create an "official" national competition.

The competitions themselves have been growing in popularity, though there are regional differences which are likely related to the activity of individual organisers. According to Marie-Pierre Bonniol, the French national organisation holds 15-25 competitions and a large final every year, including up to 400-500 competitors in total, with an audience of up to 10 000 people total in all competitions. In contrast, for example, Magnus Langli of the Norwegian organisation says that they only hold one competition each year. Though the events are often sold out, they are usually held in smaller venues that hold up to 350-400 spectators.

3.1.2 Changes in Attitudes Towards Rock Music

Perhaps there had also been a change in attitude towards rock music in general. The early forms of rock music in the 1960's were all related to youth subcultures, often connected with rebelliousness. The same attitude resurfaced at each stage where the previous forms of rock had become mainstream – in 1970's *punk* movement, and later in the rise of *alternative rock* in the 1980's. Each decade saw several shorter and smaller-scale movements centred around certain bands or groups of bands, such as *rockabilly* and *psychedelia.*

Since the 1990's, rock music had been declining in popularity. The Recording Industry Association of America (RIAA) has gathered annual consumer profiles since 1989, dividing music sales by genre [39, 40]. Figure 3.1 shows that the popularity of the rock genre had not changed much on the overall. It would be much more interesting to see demographic data on the people who purchase rock music and see if that has changed over the years, but unfortunately such data has not been gathered before around 2000. Therefore, I can only rely on speculation to say that the generations who grew up in the 60's, 70's and 80's each listen to the rock of the 2000's with nostalgia, and have lost their rebellious nature.

Additionally, in my personal experience, it seems that the 2000's Internet culture of irony and subtle sarcasm had made its impact on the perception of

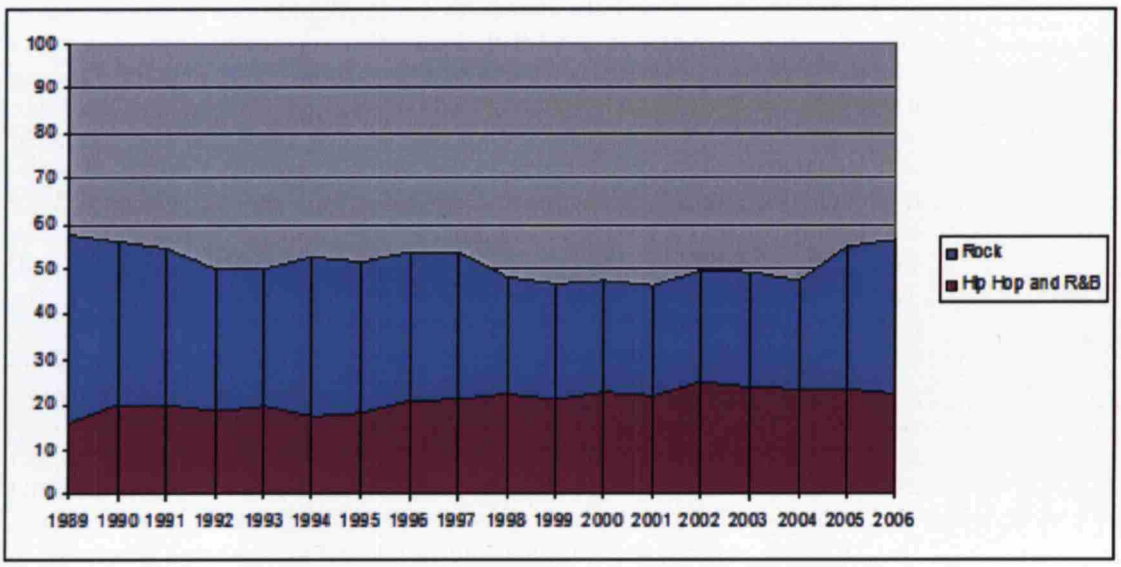


Figure 3.1: Percentage of US record sales in the rock music genre compared to other genres between 1989 and 2006.

rock music as well. As with any retro movement, the original culture is seen from a different perspective with a combination of freshness and humour. Where in the 1980's the *glam metal* genre with its big-haired rockers clad in form-fitting leather was all the rage, in the 2000's it was considered silly but also remembered with fondness. Rock music had not lost its image of defiance, but the people around it had changed and no longer considered it such.

An example of this can be seen in the 2006 Eurovision Song Contest, won by the Finnish monster rock band *Lordi*. Their music took inspiration from 1980's *hard rock* and *glam metal* – they had started out as a *Kiss* tribute band – and their stage show consisted of all band members carefully masqueraded as monsters, complete with spectacular pyrotechnics. The Eurovision contest had up until then been all about pop music, and had never featured anything even remotely related to rock. Lordi, however, was a huge success. Though it is not within the scope of this Thesis to analyse this success thoroughly, it is my interpretation that this success was a result of an ironic attitude towards rock music – it had lost its shock value due to the desensitisation of consumers and popularisation of rock culture, but at the same time still retaining an image of a counter-movement against the generic pop music that had dominated the Eurovision until then.

3.2 Existing Research

In recent years, there has been an explosion of discussion circling around buzzwords such as viral marketing, buzz, Web 2.0, blog marketing, Internet memes and so on. The field is as fragmented as it is new, and more literature is being produced by marketing professionals than academics. I will primarily use the framework of *word of mouth* to analyse the media boom.

	Main focus of study	
Unit of analysis	*Antecedents to word of mouth*	*Consequences of word of mouth*
Receiver of communication	**QI:** 'Why do people listen?' *Related variables:* external information search, product category (perceived risk), type of relationship with source (tie strength)	**QII:** 'The power of word of mouth' *Related variables:* key communication effectiveness variables (awareness, attitude change, behavioural intention, purchase behaviour)
Communicator	**QIII:** 'What makes people talk'? *Related variables:* opinion leadership, satisfaction/dissatisfaction, promotional activities/direct influence of advertiser	**QIV:** 'What happens to the communicator after the word of mouth event?' *Related variables:* cognitive dissonance, ego-enhancement

Table 3.1: Four areas of word of mouth literature as presented by Greg Nyilasy [9, p. 168].

Word of mouth itself is a very elusive term. Greg Nyilasy's chapter in the book *Connected Marketing: The Viral, Buzz and Word of Mouth Revolution* [9, pp. 161-184]provides a summary of academic research on the topic. A starting point for a definition can be taken from Johan Arndt's book *Word of Mouth Advertising:* "Oral, person to person communication between a receiver and a communicator whom the receiver perceives as non-commercial, concerning a brand, a product or a service" [1, p. 3]. According to Nyilasy, this definition is fairly universally accepted in marketing research.

Nyilasy divides the existing research on the topic into four quadrants, presented in Table 3.1. Quadrant III is of particular interest for my research, because it may help answer the question of why the concept of Virtual Air Guitar was featured in many blogs and other online discussions. Unfortunately, most of the existing research in this quadrant concentrates on identifying *opinion leaders,* people who are influential in that others listen to their communication about a product category for some reason or another. While it is important for marketers to find opinion leaders to start word of mouth campaigns, for the purposes of this Thesis it is assumed that the opinion leaders have already been identified: the people who wrote about the Virtual Air Guitar in their blogs and discussions.

Of interest to this Thesis would be research studying the properties of the object of word of mouth – in this case, the Virtual Air Guitar concept and its brief presentation. With the resources I had allotted myself for background research, I was unable to find literature on this. If such research indeed does not exist, then this Thesis is important because it presents a foray into that field, however brief.

3.3 Measuring and Evaluating Popularity of Internet Phenomena

When I say that the Virtual Air Guitar was popular, what exactly does that mean? After all, there was only a single actual device located in Heureka, and yet knowledge had spread far beyond the borders of Finland. How can the level of awareness about a concept be measured? The idea of Virtual Air Guitar and the example video were featured in web magazines, blogs and message boards as something to discuss about. Unfortunately, both methods for collecting data and data itself on Internet phenomena is difficult to obtain for comparison.

As with any media, both the amount of sources and the content of the writings themselves should be analysed. The amount of sources was derived from Google. From February 2006, the number of pages produced by searching Google (later called simply *Google hits*) with the exact phrase *"virtual air guitar"* was recorded every day. This is the number of web pages that contain the search term. Essentially, the figure consists of the amount of articles written about the Virtual Air Guitar, open message board discussions mentioning the project, and blogs discussing or linking to it. The figure does not include pages or discussions that require the user to register before they can view the site's content, because these are not picked up by Google.

At the start of recording, most pages were related to this research project instead of some other virtual air guitar. Google hits inevitably contain duplicate pages and mis-hits, so the number is not an absolute measure, but is good for tracking trends.

However, Google Hits cannot be used to measure the exact popularity at a given date. The reason for this is because a part of Google Hits are cumulative over time. Static articles and blogs remain in Google's search results for as long as they remain public, regardless of whether there is active discussion in them or not. Discussions on message forums are removed over time because some forums prune old discussions themselves, which explains why the number of hits can go down as well.

While the plain number of sources is useful for measuring the amount of attention, the opinions of the writers and readers must be tracked in some other way. I randomly chose several blogs with themes varying between art, technology and humour, and read through the user comments. I then analysed the comments, keeping in mind the behavioural specifics of Internet message boards.

3.4 Popularity Analysis

3.4.1 Video Downloads

A demonstration video of the Invisible Guitar was featured on the research web site, hosted on TKK's Telecommunications Software and Multimedia Laboratory's web server. Server logs showed that in the two days following the New Scientist article (which linked to the video), the video had been downloaded over 100 000 times. After this, the server had crashed because of the overload. The video was then re-hosted on the New Scientist site, and some other media

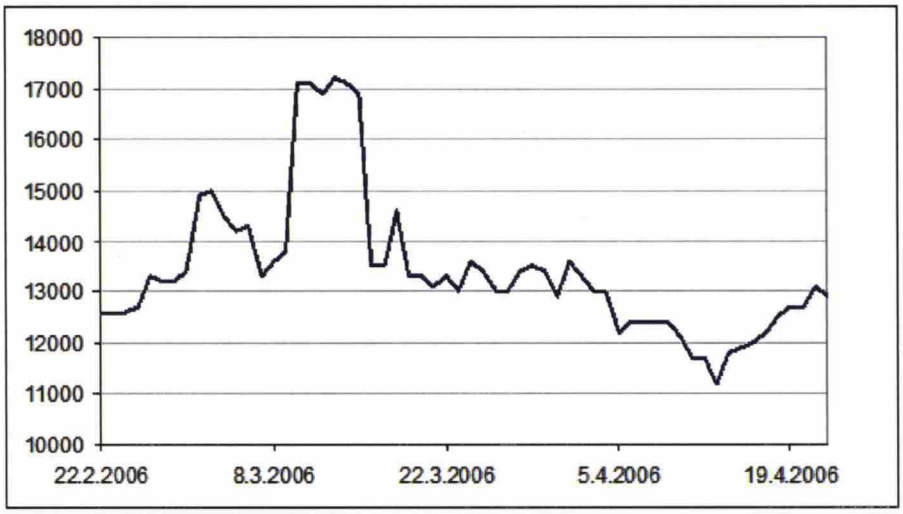


Figure 3.2: A graph showing the number of Google hits matching the exact phrase *"virtual air guitar"* between February 22nd and April 22nd, 2006.

outlets also hosted the video, such as the web site of the German newspaper Der Spiegel. Therefore, further downloads have not been recorded, unfortunately.

3.4.2 Google Hits

During the initial 3 months, Google hits were not recorded systematically, and so the data for this period is based only on infrequent observations. The number of hits began to increase in two weeks after the initial stories on New Scientist and the first blogs. They had reached 12 600 by the time monitoring began. Figure 3.2 shows the number of hits recorded every day between February 22nd and April 22nd, 2006.

3.4.3 Blogs and Message Board Discussions

Of the 16 000 hits, only a small number were web versions of articles in traditional media outlets. The majority were mentions of the Virtual Air Guitar in various blogs and discussion forums. Many blogs linked to or replicated the story of another blog, but most included user comments specific to each blog.

In all discussion forums regardless of theme, the majority of comments could be divided into two categories: overly positive and overly negative. The overly positive ones had users commenting on how great it is to be able to play without knowing how to play, how playing air guitar is fun, how the instrument is smart, and so on. The overly negative ones focused mainly on users claiming that playing air guitar is nothing like playing real guitar, and that the final product must be bad. All these comments were made based solely on the short article and the short example video showing a person playing the Heureka version. None of the users had ever tried playing the Virtual Air Guitar themselves.

Even though most comments were based on arbitrary data and the need for users to enforce their own views, the fact that the idea of Virtual Air Guitar

in and of itself generated so many comments is important. In my opinion, the video and web articles presented a product concept, not just technology, that anyone could easily visualise and form an opinion on.

Naturally, many of these opinions were far removed from the actual product, because capturing both the interactivity and the social context of friends hanging together while one plays is difficult to achieve on video. The demonstration video we had made concentrated purely on the technology, anyway.

Many of the positive comments concentrated on the fun aspect of air guitar as a visual show, while the negative ones focused on the system not being expressive enough for a guitarist. In fact, many users who posted negative comments claimed to be musicians themselves, and disliked how easy it was to learn to play the Virtual Air Guitar.

In conclusion, one of the main reasons why the Virtual Air Guitar spread so much over the Internet was because it was easily understandable and controversial – everyone had something to say about it, whether it was good or bad. As is usually the case, both positive and negative comments reinforced each other and kept discussions going. Had they been mostly neutral, the interest would have been much smaller.

3.5 Comparisons to Other Phenomena

Google hits and message board analyses may not apply to all types of phenomena. Still, some rough comparisons can be drawn based on common facts. The Virtual Air Guitar never received its own entry in *Wikipedia*, but is featured as a brief mention in the Air guitar article [22]. It's also not listed in Wikipedia's List of Internet phenomena [34], which contains examples of some of the most popular memes. The peak of 17 500 Google hits is relatively small compared to others on the list: 850 000 for "all your base are belong to us", 314 000 for the "Star Wars kid", and 103 000 for "badger badger badger" (all measured on 31.8.2007).

YouTube videos may also be compared to downloads of the Virtual Air Guitar demonstration video. YouTube does not offer comprehensive statistics, but general trends may be evaluated by analysing the most popular videos of a given time frame. At a given time, YouTube lists the 100 most viewed videos in the past 24 hours, as well as the past 7 days. On 22.10.2007, the number of views of up to 24-hour-old videos ranged from 13 000 and 100 000, and up to 7-day-old videos from 100 000 to 1 000 000. The 100 000 views of the Virtual Air Guitar video in two days compares favourably to these figures, making it a fairly popular video on the average.

Chapter 4

Starting Up a Business

Our team of three developers had discussed commercialisation of the project before, but only in a preliminary way. We had not found a suitable business model for it, and there were too many unknown variables hanging in the air. However, the media boom proved us that the idea could have mass appeal. Many interviews had ended with the question of where to buy a Virtual Air Guitar, and whatever the product would be, the name and core concept had already gained considerable media visibility without any marketing costs.

Based on this, we decided to start commercialising the research by forming a company whose first product would be a console game based on air guitar. The company was founded by same team of three people who had developed the Invisible Guitar, but the work was effectively done by just myself and Mäki-Patola, because Laitinen had received a job at Nokia.

We decided to take advantage of the Virtual Air Guitar name that had gained publicity and brand our company with it, as well as use it as the working title for the game. However, both the game's design and technology would be developed from scratch. The main reason was that the requirements of the Heureka version were so different from a console game – the original technology was developed to support a design where science centre visitors could have fun for a minute or two, but a game must be entertaining for a much longer period of time, and the player must be able to grow better at it over time.

This chapter first presents the reasons for why we decided on a console game as the method of commercialisation. Then, I describe the challenges our team faced in founding the company and getting it operational over the first two years. I also discuss and evaluate our solutions to these challenges.

4.1 Background: Changes in the Gaming Market

4.1.1 Increasing Computing Power

Sony's PlayStation 3 and Microsoft's Xbox 360, both game consoles, had been released in 2005-2006. These new consoles had more computing power than the previous generation of consoles, released between 2000-2001. The increase of computing power in general had made it possible to create complex real-time computer vision games, because previously such computer vision technologies had been restricted to offline processing. In particular, there was now enough

computing power to study and develop real-time recognition of the human body with an off-the-shelf computer or console and a cheap standard camera.

4.1.2 Social Gaming

Based on various game industry news sources (see for example [27, 28, 35]) as well a few published market figures by research group NPD, we could see that the target audience of gamers was expanding – or rather, game developers and publishers wanted to expand. The so-called *hardcore gamers* were a market that was no longer growing, and there were much more gamers who could have bought games, but did not enjoy games targeted for the hardcore audience. So, publishers were looking to expand into this audience, which was not yet fully defined. *Casual games* had just begun to be successful in 2005-2006, mostly consisting of simple, web-based games that did not require hours of learning or highly developed gaming skills – games that could be played anywhere for a little while at a time.

Casual games consist of several subcategories, ranging from puzzles and card games to simple reaction games. Many of these are not social, but rather meant to be played alone for a few minutes at a time – for example, on a break at the workplace. Despite this, they played an important part in the success of Guitar Hero and similar games. This is because publishers and retailers tended to divide games into only two major categories: traditional, *hardcore* games, and casual games. Basically, anything that wasn't a traditional game tended to be classified as a casual game, and therefore, it can be speculated that the overall success of single-player casual games also helped social games be seen more favourably by publishers.

Social games (sometimes called *party* games) are similar in experience to board games and games like Musical Chairs or Spin the Bottle, which have existed long before video gaming. While the rules and games are different, the core idea is to entertain a crowd of people, preferably all at once and not just by taking turns. Either everyone can participate in the game at the same time, or those who watch the player are entertained just by the playing itself – something that is usually not possible with hardcore games. Thus, the game itself is only a part of the social environment, and may not even be the reason for the gathering.

Perhaps the most famous social game is the *Mario Party* series, the games in which have appeared on various Nintendo consoles starting from 1998. The game features a board such as one found in a traditional board game, on which players' pieces progress by rolling dice. At the end of each turn, players play very short minigames to earn points and various bonuses. Many minigames can involve two or four players at the same time. Mario Party is easy to learn even for people who have never played video games, making it popular in parties.

However, Mario Party and similar games are tied to the Japanese gaming culture. In Europe and North America, their design and presentation made them appear as games for young children or "nerds" who played a lot of games. This cultural atmosphere had also begun changing from 2004-2005, with games becoming more and more accepted as mainstream entertainment.

Figure 4.1: The *Guitar Hero* guitar controller.

4.1.3 Music Games

The first social games to make an impact in these areas were dance and karaoke games, which coincided with the spreading of (non-videogame) karaoke.

Dance games are one example of *rhythm games*, an important genre games of social games. In these games, players must perform rhythmic controls in time to music, such as pressing buttons on a gamepad or hitting drums. The controls are usually simple and easy to learn, so that the player can better focus on the music and rhythm [32]. These games had been successful predominantly in Japan, but a few games such as Konami's *Dance Dance Revolution* series enjoyed success in USA and Europe as well.

Karaoke games are also included in the term *music game*, even though they are based on pitch detection of the singing voice instead of rhythm.

4.1.4 Guitar Hero

The release of *Guitar Hero* in late 2005 in USA and Europe marked a new trend for music games as reported much by the various game industry news outlets. The game was developed by Harmonix Music Systems, Inc. and published by RedOctane, Inc. *Guitar Hero* came with a plastic guitar-shaped controller, shown in Figure 4.1. The controller has five buttons on its neck (*fret buttons*) and a *strum bar,* a large button on the body. The player is instructed to hold down one or more of the fret buttons and press the strum bar in time with the on-screen instructions, creating the illusion of playing a guitar. The game's music was classic rock, in contrast to the techno and Japanese pop usually found in music games – even *GuitarFreaks*, from which *Guitar Hero* had been cloned and which was first released in 1998 in Japan.

We were experimenting with the game at the same time as the media boom took place. Even in just the month it had been out, the game had already become a media phenomenon itself, and everyone was talking about it. *Guitar Hero's* marketing campaign had been aggressive, and had generated much more awareness on the Internet than its relatively low sales figures would suggest – which were partly claimed to have been due to difficulties in manufacturing the hardware. The sequel, *Guitar Hero II*, however, sold much better.

4.1.5 Physically Interactive Games

Physically interactive gaming is a relatively new term. In the game industry, such games are still rare, and are not categorised together systematically. In academia, Johanna Höysniemi has discussed physically interactive games at depth in her dissertation [4], and defines them as games that require physical exertion to play. She further categorises existing games into three subtypes: perceptual games that observe the player's position and movements, dance and rhythm games that require movement in time to music, and exercise entertainment where traditional physical exercise is augmented or made more entertaining by various gaming devices.

Physically interactive games had been rare and mostly experimental until 2005, and most also had a proprietary controller and technology developed only for the one game. The first mainstream games to reach popularity were Sony's *EyeToy* games for the PlayStation 2 console, which came with the *EyeToy* camera that could be attached to the console. The *EyeToy: Play* series consists of three collections of mini-games, each of which uses the camera to draw the game on top of the video feed of the player, and simple pixel difference to detect motion to control the games.

While the *Play* mini-games were more technology demonstrations and experiments, *EyeToy: AntiGrav,* developed by *Harmonix* (who later were responsible for *Guitar Hero*) was the first attempt to create a game with as much gameplay depth and playing hours as a more traditional mainstream game, instead of a mini-game. The player controls a 3D avatar on a hovering skateboard. The objective was to reach the goal at the end of a racetrack filled with obstacles. By moving one's head and hands, the player could steer the board left and right, duck under and jump over obstacles, and grab bonuses by reaching at them.

EyeToy was notable because this was the first time that a console manufacturer offered the hardware to do any kind of tracking of body movements, so that game developers would only need to write the software for it and not have to move into the hardware business as well. Microsoft followed suit in 2006 by introducing the *Live Vision* camera for the Xbox 360 console, though video chat was the only application to utilise it. Sony also released a new version of the *EyeToy* for the PS3, called the *PlayStation Eye*. All *EyeToy* games were very successful in Europe, but less known in the USA, and almost non-existent in Japan.

However, out of Japan in 2006 came the *Wii* console, a platform for physically interactive games, developed by the third large console manufacturer, Nintendo. One of the Wii's main features was its motion-sensitive controller, the *Wii Remote*, containing both accelerometers and a camera that monitored static infrared lights placed on top of the TV screen. The Wii became a huge success in all major market areas (Japan, North America, Europe and Australia), and many of its games utilised the Wii Remote in one way or another – though usually not as the basis of the entire game, but more as a gimmick to be used in certain parts of the game.

4.1.6 Gaming Peripherals

Most games are developed to operate with the game platform's standard controller – keyboard and mouse on the PC, and gamepad on consoles. Some

Figure 4.2: Examples of specialised game peripherals. Top left: a dance pad for *Dance Dance Revolution*. Top right: controllers for *Steel Battalion*. Bottom left: a chainsaw controller for *Resident Evil 4*. Bottom middle: two microphones for *SingStar*. Bottom right: The *Guitar Hero* guitar controller. Bottom right: a slime controller for *Dragon Quest VIII*.

games, however, come bundled with a peripheral that can be used either for custom input or output specifically for the one game. Since around 2004, these specialised peripherals had become increasingly popular in game packages.

Perhaps the most widely known example of custom controllers is the *dance pad*. While many versions have been developed since 1983, perhaps the best known dance pad is featured in Konami's *Dance Dance Revolution* series of games, first sold in 1998. The controller is a large mat, placed on the floor, with four directional arrows on which the player must step in time to instructions given by the game.

Other such controllers include the microphones of *SingStar*, a karaoke game where the game analyses and scores the player's singing performance, and the collection of joysticks, foot pedals and over 30 control buttons bundled together with a special edition of *Steel Battalion*, a futuristic combat game where the player controls a two-legged tank.

Other controllers have less to do with the functionality of the game, but relate to the game's design in some way. These controllers duplicate the functionality of a standard gamepad, but feature a different visual design as novelty value. Examples are the chainsaw controller bundled with a special edition of *Resident Evil 4*, a game where the player battles zombies with, among other weapons, a chainsaw, and the Dragon Quest Slime Controller, modelled after one of the game's characters. The Slime Controller was not actually bundled with the game, but sold separately by third-party manufacturer *Hori*.

Pictures of all of the mentioned controllers are shown in Figure 4.2.

Though there have been custom peripherals ever since there have been stan-

dard ones, it is unknown why a markedly larger number of successful games have begun featuring them in the early 2000's. Peripherals add a significant marketing cost to the game – larger and heavier game boxes cost more to transport, and retailers charge for shelf space by the metre.

I would speculate that some of the reasons for this could be that as both production and marketing budgets have grown over time, the extra logistics and retail costs associated with peripherals are no longer as significant as they used to be. And in the case of music games such as *Dance Dance Revolution* or *Guitar Hero*, good design ideas had resulted in completely new game experiences – particularly for the social gaming audience.

The end result was that peripherals such as the *EyeToy* camera described in section 4.1.5 were now attractive to publishers, both because it offered a new type of game experience, and because the costs of bundling them with games were manageable in their eyes.

4.1.7 Summary

The decision to develop the Virtual Air Guitar concept into a console game came from a combination of factors. Our team's background and interests were in computer vision and game design, and we believed we could begin developing the second generation of camera-based games that would be significantly improved from the existing games that we saw as experiments with the new technology. Processing power had increased enough to allow real-time human tracking, and cameras were both widely available and even sold for game consoles. Finally, the rise of social games in general had publishers searching for more concepts for this growing audience, which was a market opportunity for us.

We had a choice between the PC platform and consoles, but consoles seemed technologically a safer choice at the time. Web cameras for PCs were extremely varied, ranging in quality from very good to very poor. On most occasions, the camera drivers would not have allowed us to automatically calibrate the cameras, forcing the user to calibrate it instead, which was deemed too difficult for the target audience of the game. Finally, there were so many cameras that we saw compatibility tests as extremely difficult. On the consoles, however, none of these issues would be present, because both manufacturers would only allow one standard camera to be connected, and there would likely be low-level access to it as well. Therefore, PC-based hardware would have been difficult to develop a stable system for.

Additionally, PCs were only just beginning to develop into home entertainment centres at the time. Most consumer PCs were still work computers in the corner of a work room. At the same time, there were major changes happening both in game console hardware with a new generation of consoles as well the rise of casual and social gaming genres.

Guitar Hero was the final major reason behind the decision. We did not see it as a direct competitor from whom we would have to steal the audience. Rather, we thought it had opened up the market for social games that featured guitars and rock music, and could be used as a reference to publishers to prove that the Virtual Air Guitar could be a success as well.

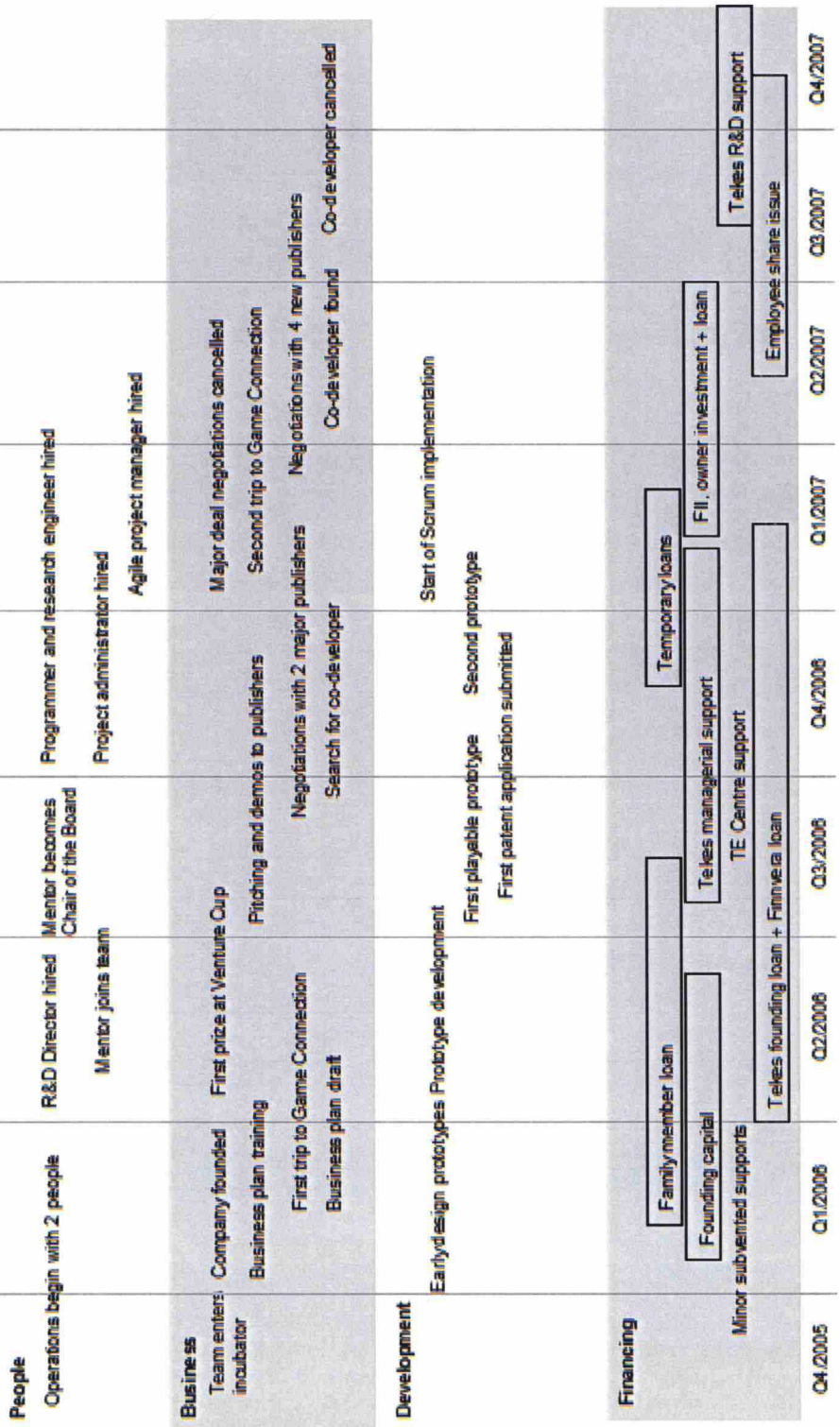
The main driving idea for our game was not music itself, like in Guitar Hero, but the ability for the player to use her body as a controller, and see herself on a virtual stage, complete with a reactive, virtual audience. Air guitar is a visual

performance and a dance, and we wanted that playing the game well would actually make the player give a visual performance. Air guitar is also equally about poses and gestures as it is about rhythm, so the game should be focused on both.

Guitar Hero was a social game, yet it had some major flaws in this area. The basic package came with only one guitar controller, basically forcing the game to be played by just one person at a time. Combined with lengthy songs, other players had to wait long for their turn to come. Additionally, the graphics of Guitar Hero were simple and cartoon-like, and dominated by instructions for the player. And while it was fun to watch someone playing a plastic guitar, most of the time players concentrated so hard on pressing the buttons that they didn't move at all. We wanted to give the audience more chances to interact with the game, both directly and indirectly, as well as provide a better show for them to watch.

Therefore, we began to design a console game from scratch based on the core idea of playable air guitar with the goals of longevity, more realistic sound, and most importantly, an expanded rockstar experience. The latter would come to mean not only hearing the sound of playing, but also playing known rock classics, having the player appear on a virtual stage, and an online video sharing community.

4.2 A Brief History of the Virtual Air Guitar Company



4.3 Challenges

4.3.1 Finding the Right Contacts

Why are contacts important in starting up a business? How did we acquire ours?

We soon learnt that we would need contacts to help us set up basic business processes, learn about the industry, conduct market research and other consulting – after all, the founders rarely have either the time or the expertise to handle every single aspect. Primarily, though, the importance of contacts are financing and partnerships.

Through the TKK Innovation Centre, we contacted Technopolis Ventures Ltd., a business incubator located near the TKK campus. While its parent organisation, Technopolis Group Plc., is a business that rents office space; the incubator itself is a non-profit organisation funded by the Finnish government through Tekes. Through the incubator, we were able to contact people in government institutions from which we would later apply funding, venture capitalists, and a mentor who became our chief negotiator.

With the incubator's help, we also expanded our network of contacts to Neogames, an organisation that assists Finnish game companies with networking, business development and applying for financing. Through them, we contacted most of the few Finnish game companies out there, from whom we received some guidance in becoming a game developer.

Technopolis Ventures saw potential in our business idea, and provided more help than they usually do to start-ups. Our assigned coach spent 40 hours on our company in February, when the typical time spent is 4 hours per month. We were also able to turn down two initial offers for venture capital and one agent, none of which would have been good choices. Finally, we received coaching and opinions (being careful to ask for several different opinions) with regards to proceeding in the initial negotiations.

4.3.2 Business Plan

We needed to find funding for our company, and to do that, we had to sell our business idea to financiers. From another perspective, we also had to figure out how to make a viable business out of a concept. The solution for this was to write a business plan.

A business plan's purpose, as it is currently seen, is to communicate the company's goals and the plan to reach them to outside parties, primarily financiers. The business plan is a snapshot of the company's strategy, and should be separated from actual internal planning. It is essentially an advertisement directed at a financier. The business plan does not contain internal operational planning, meaning the day-to-day activities of the company, product development, and so on.

We received a boost to our writing of the business plan from the national Venture Cup competition. This competition, held annually in Finland, helps entrepreneurs build a viable business plan that has a good chance of acquiring venture capital. Additionally, at the same time we participated in two coaching programmes at the incubator, one for writing the plan, and another for pitching it. These proved to be highly valuable to us, because they offered a strict

deadline for finishing our business plan as well as personal feedback from people who had read quite a number of plans before.

Though we missed the first phase of Venture Cup, we were among the ten winners of the second phase, and won first prize in the third and final phase in early summer 2006. It is interesting to note that in previous years, the winners of Venture Cup had mostly been based on business-to-business ideas, with nothing related to the entertainment industry.

The comments we received from the jury indicated that we won because our business plan had a clear market potential: publishers wanted to expand their customer base but lacked in concepts to do it with, and platform holders were looking for better games that would help sell their camera peripherals. Another strength of the plan was that we weren't going to attempt to do everything ourselves, but find an established game developer as a partner. We had made this choice because we had been told by our contacts in the game industry that the most important thing in getting a good publishing deal is a track record of previously developed games, which we obviously didn't have.

Equally important to the business plan was presenting the business idea in a compact form, called *pitching*. The first contact to a financier is usually a short 5-minute presentation about the business idea and why it is a good investment. This pitch includes the idea itself, the business model, and financing model. In this, we were glad to have been interviewed so many times. The interviews had helped us see what parts about the idea itself were important, and they had also given us practise in presenting in the English language – not to mention a boost of confidence.

But pitching a business idea to an investor, or even a game concept to a publisher, is a different thing. At the incubator, we took part in Pitch Camp, a training programme for writing and practising pitching to an investor or client. Even if our business plan had been the same, without the pitch training we might not have been able to communicate it face to face, which is required before anyone even reads the plan itself.

4.3.3 Financing

To acquire financing, we needed a business plan, a pitch for presenting to financiers, and contacts who would lead us to the financiers.

We did not want to sell off a part of the company until after patents had been submitted and a publishing deal acquired, the both of which we believed would happen in the first year. This meant that the initial funds to start up basic operations would have to be public funding and private loans.

The three founders each contributed to the minimum capital of a limited company, and we began the process to apply for a founding loan from Tekes (Finnish Funding Agency for Technology and Innovation) as well as a private loan from the state-owned financing company Finnvera Plc. Both were successful, partly helped by Venture Cup, which had helped us make a good business plan. We also applied for various subvented programmes that offered consulting, which are described later in this chapter. Finally, a private loan from a family member of one of the founders was acquired. Once Pirjo Kekäläinen-Torvinen had joined the team as Chairwoman of the Board, she both invested in the company and provided smaller loans as well.

It was a challenge to stretch the funds, because at the time, most government funding programmes were exclusive. We could not receive funding from two programmes at the same time, even if they were not for the same costs. We had to abandon some useful programmes and concentrate on the one with the largest sum available, namely the founding loan. The loan was meant to cover only 50% of costs, but could be applied to any founding costs, ranging from infrastructure and rent to salaries and outsourced prototype development. The guarantee for the founding loan was provided by Finnvera's loan, which in turn was guaranteed personally by the three founders. Additionally, only half of the loan was paid in advance, and the rest would only be paid according to actual costs – meaning we had to have a buffer equal to half the loan from somewhere else. Later on in 2007, we issued shares to employees, and everyone participated.

We worked on a shoestring budget, avoiding any major investments, travelling as cheap as possible, and renting basic premises near the TKK campus instead of being in the technology village inside it. The largest part of our costs were salaries (despite the main owners receiving half or no pay for an extended period of time), rent, and travel costs for visiting publishers.

4.3.4 Studying the Market

While the two of us were gamers, we knew little about the gaming market from an industry perspective. We began to search for information ourselves, mostly searching game industry websites for bits and pieces from various news items. We also received some industry overviews from our contacts in the Finnish game industry, including the Fenix Game Business Programme Workbook, which contained presentations and sample figures for start-up game companies, gathered from business seminars [11].

We also applied to the TULI [41] programme. TULI gives inventors the chance to use consultants for e.g. a small market study or business idea evaluation, with the cost fully covered by the programme. This research was made as a desk study, presumably in much the same way as we conducted our own research. Unfortunately, our own study gave us more information – though it has to be said that in the business world there are no absolutes, and presenting ideas and figures confirmed by multiple independent parties is more credible than just internal research.

4.3.5 Finding the Right People

Where did we find our employees? How did we recruit them?

Among students looking for a summer job, or their first job after graduating, it is common to hear that contacts are everything. Now, having seen things from the perspective of a young company, it's clear why this is so. With only two over-worked people, we could not afford to start a large recruitment campaign, posting advertisements and evaluating candidates. We stuck with the people we had come to know over the course of our own studies. From this contact network, we hired the first employees – once we could afford them.

Our development team, which would grow to 6 people by January 2007, had essentially been formed before the company. All team members had been students or researchers at the same laboratory at TKK, and everyone had worked together with at least one or two other team members before. We knew each

person's skills and how to work with them. Thus, "team building" was not really necessary. Still, it was important to have a trial period of four months for all new recruits, during which the contract could be terminated by either party if things didn't work out – a common practise which was commented to be fair by both our core team and all employees.

Perttu Hämäläinen was the first hire. We had been researchers in the same office at TKK, and collaborated on some projects as well. He possessed the technical knowledge of computer vision that neither of us did, as well as experience in game design with several game projects behind him.

We were also very lucky to have met Mika Tyyskä, a guitarist and multimedia author, in March 2006 at the Top Talent Festival. Tyyskä was the creator of *Guitar Shred Show* [31], a Flash-based web game where the player could trigger guitar licks by pressing keys on the keyboard. Tyyskä was not only an excellent guitarist, but also understood game design and participated in the game's audio design. With him, we developed a system using actual pre-recorded guitar samples that was able to reproduce the rock attitude that the physical sound model had lacked. We also purchased the music content for our prototype from him.

When the first prototype was finished in August 2006, we were ready to expand the development team for the next iteration, which would take even more work. We had been talking to two more people from the same laboratory, who joined the team in December. One was Tommi Tykkälä, who had recently finished his Master's studies in computer vision, and would become Hämäläinen's partner in technology research and development. The other was Markus Eräpolku, who quit his job at a mobile game developer and came on board as a game programmer. He would begin learning the console platforms, working on the game prototypes and tools.

Finally, Juha Laitinen rejoined the company in January 2007, after having finished his year-long project at Nokia. While his programming skills were good, the team really needed what he had learnt about agile project management at Nokia.

4.3.6 What to Do with Technology Developed at University

The technology we had developed for the Invisible Guitar was partially owned by the TKK university. This would prevent us from using it commercially. How would we then turn it into a business?

The solution was to abandon the technology and concept altogether, though it came from practical reasons as well. It had been clear from the beginning that both the design and the technology of the Heureka version would not be adequate for a full-sized console game.

As described in the introduction to this chapter, we needed to develop a game that was very different from the concept of the Invisible Guitar.

No parts of the Invisible Guitar technology were used by the company, either. The Invisible Guitar remained the property of TKK, and the Virtual Air Guitar Company began to develop its own technology commercially. This technology was partly based on technology licensed from Perttu Hämäläinen, who had been developing more advanced computer vision applications both at the same university as well as in the company Animaatiokone Industries Osk. The patents

that the Virtual Air Guitar Company would later apply for were based on the next stage of this proprietary technology and not on any part of the Invisible Guitar research.

4.3.7 Prototype Development

Work on the first playable prototype began full-scale in the summer of 2006, when Hämäläinen joined the team. In two months of crunch time, the team of three worked long hours on the prototype. Hämäläinen finished the first robust version of the computer vision technology, Mäki-Patola created the core gameplay mechanics, and I mostly took care of managerial duties during the time. We ended up postponing demonstrations to the publishers we were negotiating with by a month, but being able to have their decision-making board try out the game themselves was fairly essential in going forward with the negotiations.

After this initial prototype, we began adding functionality and features to it in small steps – one or two complete features per two weeks that could always be demonstrated and tested. We also began work on testing the prototype on console platforms, not just our PC development environment, to prove that the computer vision technology would work on them as well.

Mostly, the major improvements to the playable prototype were timed with publisher visits, so that we always had a new version available to show for them. Only once the negotiations were further underway did we start implementing more of the design.

4.3.8 Short-Term Planning

The company's strategy included producing a Virtual Air Guitar game, and for this development we needed a way to set short-term goals and communicate them to the entire development team. This work was taken up by Mäki-Patola, who became the development director, and Laitinen, who implemented the Scrum methodology [14] into the company, as well as some Extreme Programming [3] practises. We certainly did not want to do another two-month crunch as described in section 4.3.7.

Scrum is not so much a full-fledged development methodology than a collection of common sense guidelines. At the core is the idea that the project is developed in short pieces, or *sprints*, that last two to four weeks each. During each sprint, the team works on a small number of features that must be completed by the end of the sprint, when they are demonstrated. Scrum is mainly about learning how to break tasks down into manageable slices that can be finished by themselves and verified afterwards. Over the next six months, the team slowly got better at breaking down work and estimating the amount of work necessary for each task.

Physically interactive games are difficult to design on paper, so we used a large number and variety of prototypes. We started out with rapid prototypes in any form we could come up with. For example, we made non-interactive versions of the instructions and then playing them back on a TV screen and trying to perform according to them. Then, once the computer vision technology had taken enough shape for testing, we were able to create interactive prototypes. We created three major versions of our playable prototype during the first year, and countless smaller updates. Designing the core gameplay mechanics were

mostly a matter of trying things out with the prototype, then writing down the results and improving on them.

Every employee working on the project was allowed and encouraged to take part in the design, both through formal design meetings as well as continuously keeping everyone up to speed of the design informally. Still, once the team grew, we appointed one lead designer who had the final say in all design matters. This became important also when the design grew in details, as it was no longer practical or even necessary to communicate every aspect of it to all employees.

However, we still had a challenge in long-term planning, because while Scrum is a methodology for planning concrete work in short bursts, it does not define any particular methods for The business plan, on the other hand, is a tool for communicating to financiers, and as such is only a snapshot of the company's plans at a given time.

4.3.9 Long-Term Planning

We were mostly unable to make detailed long-term plans for producing our games, because we did not have a publishing deal and thus no project, and no co-developer either. The computer vision technology, on the other hand, was by nature research, and thus could not be planned quite in the same way as production. Mostly, the only plan was the game's design document. It contains many of the features that need to be implemented in the game, but a lot was missing that would be the co-developer's responsibility. For a project plan, we had received some example project plans from our contacts in the game industry and supporting organisations, and made a rough draft based on them.

Planning the business development side (partners, publishing deals, etc.) was kept to the three-person board, because the development team did not want to get involved too deeply with it. When changes were taking place, the board gave updates in weekly meetings with the development team, which the development team members found to be a good way of keeping up to date, yet not being constantly involved. Mostly, these long-term plans were kept in the head of the Chairperson of the Board.

We decided that with a team as small as ours, writing down internal plans and keeping them constantly updated would be a waste of time. Instead, we tried to make sure that we communicated face to face as often as possible. While the daily 15-minute Scrum meetings were mostly centred on development, we also included some pieces of business in them. But more importantly, we held office meetings weekly, in which the status of negotiations were explained, and every time the company's future looked a little different, it was discussed openly. Additional meetings were arranged if something major happened.

Meetings were easy to arrange, as they were mostly a matter of simply calling out loud for everyone to gather up. This was the result of both a friendly atmosphere and an open office space. It was also good that all team members were interested enough in the business side of things to listen and take part in the discussions, even if they wanted the rest of their time for development work.

The overall development plan for the Virtual Air Guitar game, however, has not been formalised in any way. The development process is clear in the mind of the game development director, and he decides what each sprint consists of. However, the entire plan has never been committed to paper, and as such the rest of the team's input on it has been minimal – although each sprint is

planned together and some have changed from the original plan due to team input. On the overall, we still need to find a good way of effectively maintaining a development plan that does not rely on a single person.

4.3.10 Game Business Models

We learnt that the traditional business model of a game developer is to develop a concept and sell marketing rights to a publisher who will fund the development with royalty advances. First, the developer must have a concept for a game and a project plan. This is pitched to a publisher, and negotiations for a publishing deal are entered. Once the deal is closed, the publisher will pay for the development of the game based on development milestones. When the game hits the stores, the publisher will first cover the development cost from the revenue, and after that the developer will start getting a royalty percentage of each unit sold.

This model has several drawbacks, according to my experiences with the game industry and research conducted within the Virtual Air Guitar Company. The developer is tied to the publisher for the entire duration of the project, who may decide to cancel the project due to strategic reasons. For example, a publisher may have contracted three developers to make football games, but will cancel one of them due to redundancy. Then, the way royalties are calculated has changed over the past twenty years of the game industry's existence, resulting in worse deals for the developer. Combined with higher development budgets, many developers will never see any royalties for their games. Also, publishers often want to fully own the intellectual properties related to the game, including everything from brand to art and technology. Finally, the milestone payments may not be large enough to support a game developer that only has one running project, particularly in Finland.

Another option for acquiring funding for a game project to sell off a large part of the company for venture capital. This has the benefits of having more freedom with designing and developing the game since the publisher has no say in it, retaining game intellectual property, and being able to work on the project without waiting for milestone payments. Additionally, the goal of the investor is likely to be somewhat in line with the company itself – to grow the company as a successful game developer. However, a large investment also means giving investors the power to make dramatic decisions, and the company may have different plans for growth. Finally, if the first game project costs a third of the company in shares, what's left to sell for the next projects that also require funding?

Recently, a new model has begun to gain interest, though we do not know of any projects that have yet been completed with this model. The model itself is very traditional project funding, and has been used in the related movie industry, which is slightly more mature than the game industry. The idea is to separate each game project into a project organisation, which then applies for outside financing, such as venture capital. Essentially, the investors only own a percentage of one particular game project, and not the developer organisation itself. This way, the game developer does not have to sell off parts of itself, only of the projects it is working on.

All models have their good and bad sides, in our opinion. The traditional publishing deal is good in that once the deal is made, the project is at least

financed to the end of development. Even if the project was financed elsewhere, a publishing deal is still necessary to manufacture, market and deliver the game.

4.3.11 Getting a Publishing Deal

We needed a publisher to fund the project, handle marketing and manufacturing, and deliver the games to stores. How did contact publisher candidates, and how did our negotiations proceed?

One of the first things we did as a newly-founded company was to book a trip to Game Connection at the Game Developer's Conference, held in San José, USA, in March 2006. In Game Connection, game developers such as ourselves have a booth with a conference table. The developers set up meetings with game publishers, whose representatives visit the booths for half an hour at a time, listening to the developers' pitches.

Though we had only just founded the company and knew little about the game industry, we decided to go anyway, which proved to be a very good decision. Thanks to all those interviews we had given, we had learnt how to present our ideas for people who were not researchers. With the help of the incubator, we had prepared a pitch that dealt not only with technology, but the description of the market and projections based on the success of *Guitar Hero* and camera games, as well as work estimates for developing the game. We also had the Heureka version with us that we demonstrated – although later on, we learnt that it was difficult for people to see it as a simple prototype that would change completely.

We presented to sixteen publishers, of which eight said outright that we did not fit their portfolio or that they couldn't afford the project. The other half, however, were extremely interested, and many claimed it was the best thing at Game Connection.

Pitching our game idea to publishers was very different from pitching the business idea to financiers, even if the end result was funding for our work in both cases. We were advised to concentrate on presenting attractive marketing numbers to the publishers and keep the technology presentation to the minimum. This would have been good advice for pitching to an investor, but we discovered that for a publisher, a different approach was needed.

The most important thing was that publishers already knew the gaming market far better than we did. We didn't have to show them that the market existed – they had seen the success of Guitar Hero and knew it well enough. Still, it was important to prove that we also knew about the market by presenting rough numbers of console install bases and sales figures of notable related games.

The other major difference was our computer vision technology. That was our leading edge and our company's unique strength compared to others. We presented it as such, and it seemed to us that most publishers were extremely interested in the technology.

In presenting the game and the technology, both videos and playable prototypes were essential. Physically interactive games are difficult to present on paper. While it's true that all game presentations are better with a prototype, some traditional hardcore game concepts can be presented on paper fairly easily – especially if their unique selling points are graphical or thematic. Physically interactive games, however, are usually simpler in concept and rely on the hands-on feeling that the player gets while playing. Being a new concept,

many people that we presented to did not understand the basic gameplay of our game in presentations, but when they saw a video or even tried out the game themselves, they said it was instantly much clearer.

Often with large organisations, the negotiations for major deals are first a matter of making way to the people who have both the authority to make decisions and an interest in the idea itself. For example, many scouts are enthusiastic about new games, but cannot take negotiations forward. Conversely, the middle management may not be interested in the concept that scouts bring to them; they simply do their job in trying to make it work financially before taking the negotiations to the next level.

We continued negotiations with five publishers, providing video material, additional calculations and design documentation for the scouts to show to their superiors. Over the summer of 2006, we learnt that negotiations are not something that you go through in a few days. Six months is a short time for negotiating a publishing deal. Nine or even twelve months are more common. We slowly began to understand why they take so long – after all, at the publisher's end, the scouts deal with dozens of projects simultaneously. Their job may be simply to assess the potential revenue of a project, while for a developer the concept may be their best and brightest design – not to mention a question of life and death to the company, which of course can't be revealed in negotiations.

4.3.12 Managing a Business

At a very early stage, we realised that there was a whole lot more to running a company than actually developing the product, and both Mäki-Patola and myself were researchers without experience in running a business. How did we fill all these roles, and how did we perform at them?

It was difficult for us to spread our time between business development, prototype and technology development, and administration and daily operations. An often heard comment was, "when can we actually start making the game?" Right from the start, we were looking to hire a CEO for the company, someone who could take on both the high-level management as well as a hands-on approach on daily business.

I took on the role of CEO (or rather, Managing Director) and became the primary contact with better presentation skills, while Mäki-Patola took on the development of the prototype with better technical skills. However, the roles were not clearly split, and both of us worked on presentations, interviews, game design, financier contacts, business development and daily operations. We were both present in all negotiations, and made our presentations together. Over time, our skill differences became even less pronounced, though I did not take part in the prototype's technical implementation.

We were very much aware of the fact that our networks didn't include people with considerable business experience, and that was what we needed in addition to the research and development team. One of Technopolis Ventures' services was a mentor programme, through which incubator companies could meet with business veterans who offered guidance to start-ups for free. We met up with Pirjo Kekäläinen-Torvinen, who had over 30 years of business development experience in the manufacturing and telecom industries. She later became the Chairwoman of the Board and began working full-time as a consultant for the company, handling duties in financing and business development as well as being

the primary negotiator when talking with publishers. She had no prior experience with any entertainment industry, but her knowledge of contracts, business models, negotiation tactics and organisation structures were essential in talking with all publishers and co-developers.

Right from the start, we had hoped to hire a CEO who could do handle the "business side of things" and leave us with time to develop the product. But we came to realise that such a person couldn't really exist – after all, we were the ones who knew our product and our market the best. So, the search for a CEO became the search for a Managing Director who would be more on the same level with us, and finally this became an Office Manager, who would simply handle the daily administrative tasks but not business development.

We also lacked a producer or project manager who would have the experience of at least one finished game project behind him. We didn't know anyone who fit the requirement, though, and believed that any such people would be grabbed by the few existing Finnish game companies. In fact, the CEO of one company said that if we could find one, they'd gladly hire him first. However, we found a project manager from a telecom company through the contacts of one employee. Taina Myöhänen was the first non-technical hire, joining in November 2006 as project administrator. She would soon take on some duties of an office manager as well, and we came to realise that we didn't really need a CEO at that point.

In the spring of 2007, more people were involved in developing the game, and it was growing more complex as we were taking the design further than in the first technology proof prototype. At this point, Mäki-Patola took on the role of Game Development Director. He became the main person responsible for the development of the Virtual Air Guitar game, effectively taking on the roles of design lead and project lead. At the same time, publishing negotiations advanced from pitching to project planning, and negotiations with co-developers became more detailed and technical. Being the project lead, Mäki-Patola became more involved, up to the point of effectively taking on those duties of a Managing Director. With less PR and marketing to be done, I began concentrating more on game design, usability design and prototyping future games. The title of Managing Director was officially passed on to Mäki-Patola when I took study leave to write this Thesis, beginning in August 2006.

4.3.13 Cancelled Deals

From very early on, we negotiated with a major publisher for a deal. There were many benefits to it that were not present with other publishers we had been talking to, and would have allowed us to work on most of the aspects of the game we wanted to. Unfortunately, just after they had assigned more than just scout staff to work full-time on the project, the publisher changed strategy on a corporate level, and negotiations were cancelled because they did not have staff of a necessary quality for the project anymore after reassignments. Additionally, the second publisher candidate was highly interested in the game concept and its market potential, but the financial aspects of the deal could not be agreed on.

We had originally decided that we simply did not have the resources to negotiate with more than two publishers at the same time, so these were major setbacks to the company. In retrospect, limiting to two candidates did allow us to develop the prototype, without which we could not have got even as far as

we did, so it was not a bad choice in that sense – but more staff for negotiations might have been an even better solution.

We were already talking with a development partner, who helped us contact new publisher candidates (and some previous ones that we had not continued negotiations with). Thus, we were always progressing on some front instead of sitting back. We began looking for alternative models for financing – after all, a publishing deal does not have to be acquired before game development begins, as described in section 4.3.10.

The cancelled deals caused a delay to the first game project's schedule, which had three major effects, two of which were negative. A successful deal would have financed our game development, but now we had to keep looking for other ways to finance the company. This also forced us to operate with a minimum budget, not recruiting new people or making purchases. The other major effect was that we did not have a co-developer for the game. While we were talking with some candidates, they would not commit to a project before there was even some certainty of a publishing deal for it. We needed the co-developer to work on the game engine, and without one, we could only polish the technology and work on a part of the game's user interface.

Financing was secured, however, and though we operated on a minimum budget, we were able to focus on developing our own technology as much as we could. At the same time, we also began to realise the magnitude of the technology and the game design itself. In the first two negotiations, we had thought the schedule of one year to produce the game was somewhat tight, but it turned out that it would have been impossibly short. It was a great relief to realise that we were not in such a hurry as we had originally thought, and could now spend more time on making the technology itself more robust. We now knew much more about the game industry and how to proceed in negotiations. We had also discovered the new business models described in section **4.3.10**.

4.3.14 Significance of Media Visibility and Media Silence

The media boom described in chapter 3 was very helpful in getting our business started. Many of the people we contacted, ranging from financiers and consultants to other game developers and government institutions, had heard of us. The clear market interest indicated by the number of stories in the media, as well as the questions of where to buy an air guitar, was concrete backing for our business plan when we presented it to financiers, as well as Venture Cup. Furthermore, it got us started on the negotiations described in section 4.3.11. Many of the publisher representatives that we met had seen or read about us in the media, and some had even contacted us first.

Interview requests continued at a slow pace throughout the spring and summer of 2006. However, our negotiations were also slow, as seems to be typical in our experience. Likewise, our prototype was still under development, and our small team had enough work on building it. So, we decided to start implementing a media silence policy: we would only give out interviews if they could perceivably increase our chances of getting financing for the project more quickly. We also reasoned that the game would take a long time to develop – longer than we could keep up the hyperbole in the media with little to show, particularly when the game design might be influenced by the eventual publisher. We also did not have any marketing experts in our team.

This had the immediate effect of freeing up resources and concentration to work on the prototype. We still had the media boom behind us, which we could leverage in negotiations if needed. However, we still kept up the media silence even after the team had grown, because we did not see that it could take us forward, and we still didn't have anything to show. Also, it could have negatively affected our negotiations at the time.

4.3.15 Patents Increase Valuation

Why are patents so important? After all, patenting is an expensive and time-consuming process, does not guarantee protection, and delays scientific publications of a research team at a university. Originally, the idea of patents was to protect an invention from being copied by someone other than its original inventor. In today's commercial world, however, they are more like resources. The following paragraphs present our experiences on some of the types of patents and patenting strategies that the Virtual Air Guitar Company has seen being used.

The largest gain from patents to a company is an increased valuation. Patents are concrete intellectual property, and thus increase a company's value. They also help potential partners assess the company's technology. These are the main benefits of patents; intimidation and protection are secondary. For us, a company with no track record and only a prototype of a technology, patents were a way to prove that the technology was unique and noteworthy. This in turn, we hoped, would lead to better financing and publishing deals.

The most important point to remember is that a patent does not in and of itself guarantee protection. Any patent can be challenged in court, and only if it is defended successfully will the protection actually happen. Therefore, even if it seems that a patent will obviously protect against a known competitor, the competing company may still challenge it, causing a lengthy and costly court process. Any company applying for a patent should therefore be ready to defend it.

It is common to see companies amassing patent portfolios of several related patents, each with their own narrow focus. Sometimes, a patent challenge may end up being a comparison of portfolio sizes. Instead of going to court, one company may offer a settlement by selling licences to some of its patents instead. This may often be less costly than a lawsuit, up to the point of companies maintaining a "pricing strategy" for their patent portfolio.

Applying for a patent with the United States Patent and Trademark Office (USPTO) is also something that may not be apparent to many researchers. Only the most glaringly obvious misuses of the patent system are rejected outright. After the initial approval, the patent enters a challenge phase. During this phase, the patent is made public, and anyone may challenge it without a lawsuit by providing prior art or other means of challenging the claims. If, however, no-one challenges the patent, it is approved for good. This way, many seemingly unfair patents are accepted that cover much more than a patent is supposed to.

Chapter 5

Observations and Guidelines

5.1 The Invisible Guitar

Chapter 2 presented the Invisible Guitar, its history and an evaluation of its success. What is important to note is that it was not just a technology, but a finished project in which many pieces fell together well. While the technology consisted of simple components, they were combined in a novel way, which also could not have been done earlier without powerful enough computers. The involvement of a real customer, the Heureka science centre, was essential to having clear requirements and a direction for the project. Heureka's own activity in promoting the exhibit should not be underestimated, either.

The Music exhibition ran for one year, but after that the Invisible Guitar was moved to the permanent exhibition and has been at the science centre ever since. A copy was also made for the purposes of renting exhibitions, and has since been featured in other science centres around the world as part of a scaled-down music exhibition.

5.2 Media Phenomena

Chapter 3 described the media boom that followed the spreading of our presentation video on the net.

5.2.1 Ingredients for a Successful Phenomenon

The methods of information spreading in social networks has been studied extensively through network analysis (see e.g. [20]), so instead I focus on properties of the information itself. What, then, are the ingredients that contributed to the successful spreading of the idea? In this section, I will present some aspects of the phenomenon that I personally believe to have contributed to its success. This may not be a checklist for replicating the media boom with a different concept, but it could be an important starting point for future research on the subject.

Unique name. There are no other Virtual Air Guitars in the world, which helps a lot with Google searches. The exact search phrase "virtual air guitar" will only return relevant pages. Even a regular search with just the three words

without quotation marks (not exact phrase) still returns relevant pages about the Virtual Air Guitar.

Recognition. Air guitar is a fairly well known phenomenon – even if you've never done it yourself, chances are you at least recognise the term. Thus, the term itself carries a certain connotation with it that sets the scene even before people have read a single word of the story or seen any videos.

Understandability. The concept of a playable air guitar is easy to understand, because it's something that most people can very easily imagine even if they know nothing about the technology. Air guitar is not a technical concept, and thanks to its recognition value, people know what it means. The Virtual Air Guitar added more complexity to it, though it can be argued that it's still fairly simple to understand as "like air guitar, but with the player controlling the music." However, this was also confusing, because people did not understand the specifics of how the music was controlled. For example, many assumed that since the Invisible Guitar could not pick up individual fingers, it was limiting because the player could not choose chords – when in fact the whole point of the system was not in picking individual notes and chords, but rather in translating playing intensity to music.

Controversiality. The concept generated immediate responses on forums and blogs, which is important to keep people talking about it on the Internet. The concept may also have been an unwitting participant in the overall fight between technological innovation and traditional artistry, which can be seen e.g. in the debates of whether computer-generated animation will one day replace real actors, particularly feared by actors themselves.

Irony and entertainment value. Most Internet phenomena, particularly videos, are embedded in a culture of irony just as their consumers are. The readers of blogs expect to be entertained and to see something that makes them laugh. As described earlier in this chapter, air guitar is an ironic phenomenon by itself. Compared to other air guitar blog posts, videos and photos, however, the Virtual Air Guitar also had the novelty and "double irony" of actually being able to create music with playing. Additionally, our team's performances on the video could be seen as embarrassing and thus entertaining in the same sense as reality television.

It could be you. Air guitar isn't as strange as half of what's on the Internet. In fact, while it's easy to laugh at air guitarists, it's also something that many people have done themselves but may be embarrassed to admit. After all, it shows a side of people they may be slightly embarrassed about: the idolisation of rock stardom.

Video. I believe that the single most important component of the phenomenon was the demonstration video. Ever since Internet connections became fast enough for streaming video data, video sharing has been around, but the YouTube video sharing service gave it superior mass appeal. Launched in February 2005, YouTube's videos had reached 1.73 billion views by August 2006, with the company's market share around 40% of video sharing services [30]. In its wake, embedded videos have become almost as common as pictures on blogs – and indeed the sole inspiration behind many a blog post and joke e-mail. The Virtual Air Guitar demonstration video filled the requirements of a sharable video: short, entertaining and silly, combined with a technological innovation. The video both demonstrated the intangible concept and made people laugh. Without it, I do not believe there would have been much attention at all on the

Internet.

5.3 Research Projects in the Media

5.3.1 Finding the Right Media

The very beginning of the media boom was finding the right media that would be interested in the subject matter. In our case, this happened spontaneously through the web. Not everyone may be as lucky, but this can be compensated by contacting those media with an interest.

One of the key points in all our interviews and media stories was *fun science*. The media that contacted us were largely those who popularise science for a mass audience – media such as Discovery Channel, National Geographic, and New Scientist. These media are constantly in search of easily understandable real-life applications of high technology and research.

In addition to these traditional media, the story was picked up by many bloggers on the Internet. The roots of blogging are among the technology-oriented geeks on the Internet, and many blogs are still focused on aspects of technology. The Virtual Air Guitar was, at its core, a technological innovation, but also humorous enough to fit the need for entertainment in blogs.

5.3.2 Presenting Research Projects in the Media

How to best present research for the media? In the process of giving out interviews, we began to understand what the media is looking for when doing stories about research projects. As is common with any popularisation of science, it is not the technology itself that is interesting, but its applications. More than once after explaining the technology, we were asked the question, "yes but what does it *do*?" So, we began focusing on describing the actual playing situation, what makes it fun, and what other applications could be derived from the technology.

Concrete, real-world examples are valuable as well. For example, saying that the sound model is a mathematical simulation of the physical vibrations in a guitar string does not really explain anything. Instead, we usually explained it as follows: "Imagine there's a string attached from both ends. Now pluck the string. It vibrates and generates sound waves. What the sound model does is that it simulates the vibration of that string and produces the same sound waves electronically."

From our interviews, we have discovered that focusing on individual people is a common method in journalism of any kind. It's important for the interviewee to accept this and try to give answers that support this method. Journalists will usually only mention a few people in a story, likely those that were interviewed. This usually ends up being at odds with the good scientific practise of mentioning all sources and describing previous, related research. On several occasions, we described both the people and institutions involved in the research, but they were all cut from the final stories, with the overall tone being that we had invented the entire Invisible Guitar from ground up. At best, the ALMA project was mentioned briefly but without the names of participating universities, and sometimes the creators of the sound model were mentioned.

5.4 Business Development

In chapter 4, I described the start-up of the Virtual Air Guitar Company Oy, and evaluated it from various business development perspectives. Based on these evaluations, I have collected the following summary of guidelines.

Contacts. From the contacts we received through the university, the incubator, and Neogames, we learnt about how the game industry worked. We learnt the different business models, and what to watch out for in negotiating a publishing deal. We were also able to hear views on what publishers were potentially good or poor business partners from people who had experience with them. Finally, our contacts, particularly from the incubator side, helped us understand all the practical daily matters of running a business.

Help for communicating business idea. Venture Cup and the training programmes at the incubator provided us support in developing our business plan. We were able to find out what investors looked for in it, and polish it through the feedback we received. The business plan itself was essential in applying for financing of any kind.

Business plan. What we gained from writing a business plan was the initial organisation of thoughts on paper, which was extremely helpful in seeing the bigger picture of our business model. However, this can of course be done in different ways. The business plan was essential in all funding negotiations, both government support and venture capital. It also gave us a basis for evaluating business models when we went on to negotiate for publishing deals.

Venture Cup victory. The Venture Cup competition was important in getting the company running on fast track. By winning the competition, we gained publicity, and through that were able to speed up funding negotiations with government institutions. Additionally, it helped in speaking with potential investors, partners, consultants and recruits, though we ended up not choosing any of these that we met in the initial period after the victory.

Financing. Financing was difficult for us, and we had to spend a lot of time on applying for various small grants for specific purposes. However, we managed to avoid early venture capital, and thus have kept most of the company in our own hands. This will allow us to negotiate better investments in the future, and we have not had to worry about growing the company to get a certain profit that venture capitalists often look for.

Team. On the overall, we were very lucky in having a great development team. I do not think it was pure coincidence, though. We chose new people based on the fact that we had already worked with them before, so choices were not made based solely on technical competences. So, we knew from experience that the people fit together as a development team. Extensive team building was seen as unnecessary by us, which also seems to have been a good choice for us.

Getting a publishing deal. When contacting a deal partner for the first time, it's likely to have to go through several levels of hierarchy before reaching the decision makers. We learnt that the best way in dealing with low-level scouts is to learn what their jobs are and what they need to find out to pass the case on to the next level, and concentrate on providing as good an answer solely for their criteria. For example, a financial scout will not care about the game design, only about the numbers of the game's project plan – and conversely, even if a design scout loves the concept, it may need the verification of the

financial department to move on.

Development methodologies. Though there is no way to prove whether a different methodology than Scrum could have worked equally well for us, I believe that we made a good choice. We have not implemented efficiency metrics, and in such a small company that might not be prudent anyway. However, it is a very good sign that the development team grew from two people to six and there have been no major flaws in communication or development. We are at the upper limit, however, and recruiting more people will require splitting into two or more separate teams as well as more management.

5.4.1 Gaps in the Team

While our team has a lot of expertise in different areas, there are some places that still need to be filled.

Art Director. Without an art director, all of the graphic design for our prototype had to be outsourced. And while our team had minor graphical skills, creating presentation material was difficult and time-consuming, when there was so much else to do as well. This became even more pronounced in 2007, when we would have to create early concepts for other games than just the Virtual Air Guitar game.

Testing personnel. The development team currently only consists of actual developers and no testers. Both usability testing and quality assurance (bug testing) are needed. We had planned to hire a usability test lead all along, someone who would both plan and execute tests throughout the entire development process. At the time of writing, the hiring of this person is becoming current. Additionally, once the development project begins in full scale, one or two more full-time testers need to be hired. Thanks to Scrum and open-minded developers, we have not suffered greatly from the lack of testing so far, but this may change as the project grows.

Assistant. Especially during the first year, daily duties and office management took away time and concentration from developing the game and managing negotiations. However, we decided not to hire any personnel who could not also contribute to our core business, ie. making games. Office management duties were partly taken on by the project administrator, who could also handle daily financial tasks. This consolidation proved to be very useful.

Tech support. Currently, we have no dedicated person for managing the office infrastructure, ranging from everyone's work laptops to the company web site and overall data security. Several different people handle these tasks in addition to their main responsibilities, and everyone is responsible for their own workstation. This has resulted in problems with computer hardware, and not enough time to manage and develop internal information systems. Getting the infrastructure up and running has taken away time from business critical tasks, and could still use improvement. If we had the chance to go back, we would hire a tech support employee.

Human Resources Manager. We thought about hiring a HR manager, but decided that we did not need one, because most HR duties were unnecessary in our team. Recruitment was handled through contacts. Compensation was not an issue because of the small size of the team and our ability to discuss it openly – and of course the lack of funds in a start-up company. Likewise, performance evaluation and relations management were seen as necessary, but

they were already handled within the development team without the need for separate HR staff. There was little need for promotions because of the flat organisation model. Finally, payroll was handled by the project administrator. However, as the company grows, so does the need for someone who is capable of performing HR duties, even if an HR manager as such is not hired.

5.4.2 Media Silence

The media silence policy described in section 4.3.14 is still in effect at the time of writing (September 2007). We have not presented our projects in the media at all. The interviews we've given have been about the company in general and the media boom. However, we know from experience that for many games, marketing and hype-building can begin years before the game's release. The full significance of a media silence, or possibly ending it and starting marketing, cannot be evaluated until the first product is out, however.

5.5 Design and Product Development

Embodied gameplay, especially when it is the core concept of an entire game, requires a different approach to design than in more established game genres. Where a strategy game can be designed to a large extent on paper, embodied gameplay must be tested early and often. Of course, early testing is good for any kind of game, but for embodied games it is essential. It's important to note that testing can be conducted on various mock-ups without the need for a polished, complex and fully interactive technical prototype. Our initial "fake prototypes" made on paper and video were very useful and guided the development of the interactive prototype. Had we started out by programming the prototype first, things might not have turned out so well.

We have had a lot of success with implementing Scrum. Its main benefit to us has been, in a way, enforcing common sense. Though we have an informal implementation of an informal practise, it has brought solidity into our development process. The core idea of working in short sprints with something to show at the end has been most useful in prototype development. Additionally, by keeping everyone involved by having daily talks about what everyone is doing as well as having everyone take part in planning and evaluation, we have managed to avoid the seemingly common problem of six months passing by and no-one knowing what's going on anymore. The rapid pace has also allowed us to react extremely fast to unexpected situations, such as requirements for prototype additions to be demonstrated in negotiations.

5.6 Patenting

Patenting is important to a technology company because it is tangible proof of the company's primary competitive edge. Patents are concrete intellectual property that increase a company's valuation and credibility. The use of patents for protection is only secondary, and it comes with the price of having to defend the patents in court.

The research we had done within ALMA and for Heureka was published before we thought of patenting it. This, in our observations of the Finnish

research scene, seems to be an all too common mistake, and one that is easy to make. We certainly had not believed that the Invisible Guitar would become so popular that people would be asking us where they could buy one for themselves, and as such we had not even considered patenting before scientific articles were published. It is true that not all research can be commercialised, and of the part that can, only a part can be patented. But our experience shows that you cannot always know beforehand what will or won't make a good patent. In this sense, it was good that we discarded everything we had done for the Invisible Guitar. We bought the foundations of a new technology, and its developer joined our team. Together, we developed this technology and patented it.

5.7 Critical Evaluation and Future Work

This Thesis began life as a study on the technology of the Virtual Air Guitar, but it soon became apparent that it would be of much more benefit to look at the whole process of going from research to business. As such, the scope is quite broad, which has resulted in some cutting of corners and not going quite as deep in any of the individual topics as a more focused research might have done. On the other hand, the scope of a Master's Thesis is not unlimited, and I believe that without trading some depth for breadth, it wouldn't have been possible to see the entire picture from all perspectives.

In particular, Chapter 3 primarily suffers from the lack of a framework for analysing media attention and internet phenomena. More literature studies could be done in the field of marketing research as well as internet phenomena. While memetics, particularly when applied to "internet memes" is an active (and controversial) discussion topic informally, I was unable to find reliable academic research on it. Consequently, research on word of mouth from a non-commercial perspective would be very welcome.

Chapter 4 could have been made more robust by comparing the initial stages of the Virtual Air Guitar Company to another start-up company. This was actually my intention, but it was abandoned due to resource constraints. Still, this does not mean such a study could not be conducted – in fact, it is now simply a matter of comparing the events I have presented to those of another company.

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